

Market of Phosphoric Acid in China

The First Edition

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Kcomber Inc.

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Executive summary

These years, global production capacity for phosphoric acid (PA) has been on the rise, and China has been among the top players in terms of PA capacity. It is expected that global PA capacity will further increase, as governments around the world are paying great attention to food security in the midst of increasing global demand for food, and PA is an important link in the process.

In China, most PA production capacity is distributed in regions such as Yunnan, Guizhou and Hubei, where there are abundant phosphate ore resources. Food grade, electronic grade and industrial grade PAs are commonly seen in China currently. The output of food grade PA in China was 781,200 tonnes in 2020; it decreased slightly in 2021 mainly due to a significant reduction in Jiangsu Chengxing Phosph-Chemicals Co., Ltd. In 2022, the output jumped to 927,600 tonnes, partly due to an increase in food grade PA exports. The output electronic grade PA increased year by year during this period. As to industrial grade PA, from 2020 to 2021, the output in China increased from some 16,347,000 tonnes to about 17,071,000 tonnes. In 2022, the output decreased to 15,671,000 tonnes, mainly due to a decrease in the output of PA for phosphate fertilizers.

It is worthy to note that integration degree of China's PA manufacturers is high at present. The backward integration of Chinese PA producers was deepening from 2018 to 2022. That is because, on the one hand, some of the producers who own phosphate mines added new phosphate ore capacity to improve their phosphate ore self-sufficiency rate; on the other hand, due to the rising market price of phosphate ore, producers intended to lower production costs by cutting their purchases of phosphate ore.

PA companies are not only extending their reach to the upstream sectors but also to the downstream sectors, especially the wet process PA producers who principally engage in the phosphate fertilizer business. Their business model is moving from "phosphate ore–PA–phosphate fertilizer" towards "phosphate ore–PA–phosphate fertilizer/phosphate", indicating the volume of PA used by themselves is taking a bigger share.

China's market demand for phosphate fertilizers has remained intact. But the country's continued efforts to phase out backward phosphate fertilizer capacity in stages, any alterations in the national planting structure and fertilization practices may bring down the overall domestic demand. The overall consumption of PA in China is projected to shrink from 2023 to 2025. It is worth noting that the newly added capacity for new energy materials could spark a hike in demand for phosphate ore and PA. In addition, China's electronic grade PA capacity is estimated to reach 277,000 t/a in 2023 and stabilize at 308,000 t/a in 2024 and 2025, with consumption rising from 112,300 tonnes in 2023 to 119,800 tonnes in 2025.

Methodology

The research for the report is carried out by the following steps:

- Desk research

The sources of desk research are various, including published magazines, journals, government statistics, industrial statistics, customs statistics, association seminars as well as information from the Internet. A lot of work went into compiling and analysing the information obtained. Where necessary, checks were made with the Chinese suppliers regarding market information such as production, demand, consumption, competition, etc.

- Telephone interview

The interviewees cover:

- Producers
- Phosphorous chemical experts
- Traders
- Local governments
- Researchers
- Associations
- Equipment suppliers
- Raw material suppliers

- Data processing and presentation

The data collected and compiled are sourced from:

- Published articles from Chinese periodicals, magazines, journals, the third-party database
- Government statistics & customs statistics
- Telephone interviews with Chinese producers, traders, governments and farmers
- Comments from industrial experts
- CCM's database
- Professional database in other sources
- Information from the internet

The data from various ways have been combined to make this report as precise and scientific as possible. Throughout the process, a series of internal discussions took place in order to analyse the data and draw conclusions from it.

- Report generation

Logical analysis and ratiocination were conducted, such as supply & demand analysis and cross-checking of all data. All the data and findings obtained through the above methods will be presented in the report clearly.

- Glossary

PA: Phosphoric acid

PPA: Purified phosphoric acid.

LFP: Lithium iron phosphate

USGS: United States Geological Survey

- Unit

RMB: currency unit in China, also called yuan

USD: currency unit in the US, also called US dollar

Tonne: equals to metric ton in this report

/t: per tonne

t/a: tonne/annual, tonne per year

t/d: tonne per day

Table USD/CNY exchange rate, Jan. 2019–July 2023

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
2019	6.8482	6.7081	6.6957	6.7193	6.7344	6.8896	6.8716	6.8938	7.0883	7.0726	7.0437	7.0262	6.8826
2020	6.9614	6.9249	6.9811	7.0771	7.0690	7.1315	7.0710	6.9980	6.8498	6.7796	6.7050	6.5921	6.9284
2021	6.5408	6.4623	6.4754	6.5584	6.4895	6.3572	6.4709	6.4660	6.4680	6.4604	6.4192	6.3693	6.4615
2022	6.3794	6.3580	6.3014	6.3509	6.5672	6.6651	6.6863	6.7467	6.8821	7.0992	7.2081	7.1225	6.6972
2023	6.9475	6.7492	6.9400	6.8805	6.9054	7.0965	7.2157	-	-	-	-	-	-

Source: The People's Bank of China

1 Market information of PA (phosphoric acid)

1.1 Global overview of PA

In recent years, global production capacity for phosphoric acid (PA) has been on the rise, and China has been among the top players in terms of PA capacity. It is expected that global PA capacity will further increase, as governments around the world are paying great attention to food security in the midst of increasing global demand for food, and PA is an important link in the process.

At present, the mainstream PA production process abroad is wet process. However, there are not many Chinese enterprises that have fully mastered the wet process purification technology to produce highly purified PA. The successful few include Wengfu (Group) Co., Ltd., Hubei Yihua Chemical Industry Co., Ltd. and Anhui Liuguo Chemical Co., Ltd.

PA enterprises in China have been developing towards holding diversified product mix, and this trend will gather momentum in the future. With the development of new energy technology, new energy batteries will become a main demand growth point for the industry, and correspondingly, the industry will accelerate its transformation and development around this growth driver.

Overall, China's PA industry has mainly been developing towards the integration of ore, electricity and phosphorus products, as well as the refinement of PA products. Specifically, the integration refers to acquiring phosphate ore resources, and at the same time building its own power plants or acquiring from others, apart from the production of PA. Refinement means to shift from traditional industrial grade products to high value-added products such as food grade, pharmaceutical grade and electronic grade PAs.

- Capacity

In recent years, the production capacity of PA has continuously increased in China, with a yearly increase of approximately 2% in 2021, and then an increase of approximately 3% in 2022.

In general, the capacity for wet process PA has increased slightly, while the drop in thermal process PA capacity has continued. The production capacity of wet process purified PA accounts for approximately 10% of the total.

As to the capacity of different grades, industrial grade PA capacity accounts for about 90%, while electronic grade PA production capacity is only a small portion to the total. However, this share of industrial grade PA capacity has been slowly shrinking, as more and more enterprises have started to add production capacity for food grade and electronic grade PAs.

- Trade flow

According to the United Nations Commodity Trade Statistics Database, Morocco is the largest exporter of phosphoric acid and polyphosphoric acids (HS code: 280920) in the world. Other major exporting countries are the US, China, Belgium, etc.

Table 1.1-1 Top 5 export destinations of phosphoric acid and polyphosphoric acids (HS code: 280920) from Morocco, 2022

No.	Destination	Volume, tonne
1	India	709,871.000
2	Pakistan	637,628.000
3	Belgium	232,877.000
4	Spain	122,419.000
5	Brazil	112,400.000
	Others	241,021.820
	Total	2,056,216.820

Source: United Nations Commodity Trade Statistics Database

Table 1.1-2 Top 5 export destinations of phosphoric acid and polyphosphoric acids (HS code: 280920) from the US, 2022

No.	Destination	Volume, tonne
1	Mexico	264,505.000
2	India	195,904.000
3	Canada	134,898.000
4	Colombia	4,203.000
5	Germany	1,423.000
Others		6,232.000
Total		607,165.000

Source: United Nations Commodity Trade Statistics Database

Table 1.1-3 Top 5 export destinations of phosphoric acid and polyphosphoric acids (HS code: 280920) from China, 2022

No.	Destination	Volume, tonne
1	Thailand	90,376.820
2	South Korea	51,355.511
3	Indonesia	38,401.646
4	The Netherlands	37,277.720
5	Japan	32,541.342
Others		311,201.260
Total		561,154.299

Source: United Nations Commodity Trade Statistics Database

The top five importers of phosphoric acid and polyphosphoric acids were India, the US, Turkiye, the Netherlands and Spain in 2022.

Table 1.1-4 Top 5 importers of phosphoric acid and polyphosphoric acids, 2022

No.	Importer	Volume, tonne
1	India	2,481,743.362
2	The US	368,638.000
3	The Netherlands	350,206.642
4	Turkiye	342,196.974
5	Spain	291,364.486

Source: United Nations Commodity Trade Statistics Database

- Production method

PA production methods are mainly divided into thermal process and wet process. In China, thermal process PA is mainly used in higher-end industries such as food industry, battery industry, electronic industry, while wet process PA tends to be used in fertilizers. That's mainly because China's phosphorus ores has relatively lower P₂O₅ content and such ores cannot yield good quality PA through wet process. By contrast, wet process PA in foreign countries accounts for about 85%–90% of the total production capacity, and many countries can directly use wet process PA to produce industrial grade and food grade PAs.

Under the constraints of policies on energy consumption and environmental protection, China's thermal process PA capacity has gradually contracted. With headway made in dual control policy (on energy consumption and energy intensity) and in purification technologies, the share of wet process PA capacity to the national total will further increase.

Meanwhile, in recent years, wet process purified PA, with lower energy consumption and less production cost, has gradually gained some market shares previously held by thermal process PA. In the long run, although overall downstream demand for PA will steadily increase, the demand for wet process purified PA will expand at a faster pace under the influences of environmental protection policies, rapid development of new energy vehicles and booming energy storage market.

- Upstream raw material phosphate ore

The global distribution of phosphate ore is severely uneven, with China, Morocco, and the United States being the main suppliers of phosphate ore.

Table 1.1-5 Grade, reserve and output of phosphate ore in China, Morocco and Western Sahara, and others

No.	Item	China	Morocco and Western Sahara	Others
1	Average grade of phosphate ore (calculated as P ₂ O ₅)	18%	39%	30%
2	Phosphate ore reserves to world total	5%	70%	25%
3	Proportion of phosphate ore production in 2021	40%	17%	43%

Source: CCM & USGS

The world's phosphate ore export centers are concentrated in Africa, mainly in Morocco. In particular, Moroccan state-owned enterprise Office Chérifien des Phosphates (OCP) Company monopolizes all aspects of its domestic phosphate industry chain, becoming the world's largest phosphate ore producer and exporter, and playing a big role in deciding world phosphate ore price.

The supply of phosphate ore in China has been put under pressure for quite a while as the central government has been tightening its policy on phosphate ore mining. China has intensified safety and environmental protection checks and rectifications in recent years, and the trend has been set, which implements "phosphogypsum disposal determines output" policy and requires harmless treatment of phosphogypsum.

- Development of major PA downstream sectors

Phosphate

Phosphates, as one of the important downstream applications of PA, are widely used in food, medicine, daily chemical and other fields after years of development. Some phosphates are irreplaceable. At present, global production capacity for phosphates is at about 3 million t/a, with China's capacity accounting for over 40%.

In recent years, the development of phosphate industry has shown the following trends:

- First, developing towards refined products, that is to say, from industrial grade to food grade and pharmaceutical grade. The scale of high-end refined phosphates has continued to expand, and gradually captured leading positions in main markets of food grade and pharmaceutical grade phosphates at home and abroad. And also accelerating the breakthrough development towards electronic grade products to meet the needs of more high-end fields;
- Second, developing from common products towards special-purpose ones and specialty products, with application fields widened;
- Third, the production of common phosphates shifting from China to the developing countries in

Southeast Asia. Phosphate production in developed countries has decreased, but added-value of their products has been on the rise. Developing countries have been gradually occupying low-end industrial phosphate market, and some big enterprises there have been trying to enter high-end market.

New energy

With many countries having set their carbon peaking and carbon neutrality goals, new energy vehicle market has been growing at a high speed. Besides, the development of energy storage market has been put on the fast track. Specifically, the demand for lithium iron phosphate (LFP) battery has recovered. The new energy industry has been gradually becoming an important downstream sector of the phosphorus chemical industry.

So far, quite a few Chinese enterprises have dabbled in the new energy industry. In the long run, as markets of downstream products of PA are expanding from agricultural chemical sectors to new energy material sectors, the demand for PA will grow further and thus support a sustained growth of PA industry.

1.2 Properties of PA

1.2.1 Properties of food grade PA

Compared to PA of other grades, national standard for food grade PA mainly focuses on the content of arsenic and lead. Particularly, arsenic content should be less than 0.00005%.

Table 1.2.1-1 Standard for phosphoric acid as a food additive in China

No.	Item	Specification
1	Phosphoric acid (H ₃ PO ₄), ω/%	75–86
2	Fluoride (calculated as F)/ (mg/kg) ≤	10
3	Readily oxidizable substances (calculated as H ₃ PO ₃), ω/% ≤	0.012
4	As/ (mg/kg) ≤	0.5
5	Heavy metals (calculated as Pb)/ (mg/kg) ≤	5

Note: This standard targets food additive phosphoric acid, and currently there is no specific standard for food grade phosphoric acid in China.

Source: National Food Safety Standard for Food Additive Phosphoric Acid (GB 1886.15-2015)

Food grade PA is mainly used as an additive in the food industry and other daily industries, as well as in the preparation of food grade phosphates. It can be used as an acidity regulator, a yeast nutrient source, sometimes as a substitute for citric acid and malic acid, etc. In dairy and brewing industries, its addition not only serves as a nutritional source for yeast, but also helps prevent the proliferation of bacteria.

In the field of water treatment, it is mainly used as a water softener, scale remover, and as a raw material for phosphate-based water treatment agents.

China is currently the world's largest producer of food grade PA; its output can meet domestic needs and at the same time export in large quantities. It is expected that China's food grade PA industry will have increasing dependence on foreign markets in the future.

As for the downstream application, food grade phosphates, there is a high demand for and a wide variety of these products. Food grade phosphate industry still enjoys much room for further development, and it is expected the growth will drive up the demand for food grade PA.

1.2.2 Properties of electronic grade PA

Electronic grade PA, among PA of all grades, has the highest purity requirements, with impurity content measured in ppm and ppb.

Table 1.2.2-1 Standard for electronic grade phosphoric acid in China

No.	Item	Specification	
		E1 (Common)	E2 (High purity)
1	Phosphoric acid (H ₃ PO ₄) (85%), ω/%	85–87	85–87
2	Readily oxidizable substances (calculated as H ₃ PO ₃), ω/% ≤	0.005	0.001
3	Nitrate (NO ₃ ⁻)/ (mg/kg) ≤	5	0.5
4	Sulfate (SO ₄ ²⁻)/ (mg/kg) ≤	10	5
5	Chloride (Cl ⁻)/ (mg/kg) ≤	1	0.5
6	Al/ (μg/kg) ≤	200	50
7	B/ (μg/kg) ≤	/	50
8	Sb/ (μg/kg) ≤	3,000	300
9	As, Ba, Cd, Cr, Co, Pb, Mg, Mn, Ni, K, Ag, Sr/ (μg/kg) ≤	100	20
10	Ca/ (μg/kg) ≤	1,000	50
11	Cu/ (μg/kg) ≤	50	20
12	Ga, Au, Li/ (μg/kg) ≤	100	10
13	Fe/ (μg/kg) ≤	300	50
14	Na/ (μg/kg) ≤	500	50
15	Sn/ (μg/kg) ≤	/	10
16	Ti, Zn/ (μg/kg) ≤	100	50

Source: National Standard on Electronic Grade Phosphoric Acid (GB/T 28159-2011)

Electronic grade PA is mainly used in high-tech fields such as semiconductors and optoelectronics for chip cleaning and etching; it can also be used to prepare high-purity phosphates.

Semiconductor industry is a key downstream sector for electronic grade PA. With continuously shortened processes for chip manufacturing, requirements on the quality of PA for chip production have been becoming increasingly higher, so has been the production difficulty.

The rapid transfer of production capacity for semiconductor chip and liquid crystal displays to China in recent years has steadily brought up domestic demand for electronic grade PA, especially for the uses in etching and cleaning processes for semiconductor devices, in etching process for integrated circuit microfabrication, and in thin-film transistor liquid crystal display (TFT-LCD) manufacturing. In the future, with global economic development and accelerating digital transformation, market demand for electronic grade PA will increase. In response to increasing requirements for electronic grade PA quality, new production technologies will be developed.

1.2.3 Properties of industrial grade PA

Industrial grade PA is generally classified into two specifications in China: 75% and 85%, with relatively low requirements on purity.

Table 1.2.3-1 Standard for industrial grade phosphoric acid in China

No.	Item	Specification					
		PA (85%)			PA (75%)		
		Superior	First grade	Qualified	Superior	First grade	Qualified
1	Chroma, Hazen ≤	20	30	40	20	30	40
2	Phosphoric acid (H ₃ PO ₄), ω/% ≥	85	85	85	75	75	75
3	Chloride (calculated as Cl), ω/% ≤	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
4	Sulfate (calculated as SO ₄), ω/% ≤	0.003	0.005	0.01	0.003	0.005	0.01
5	Fe, ω/% ≤	0.002	0.002	0.005	0.002	0.002	0.005
6	As, ω/% ≤	0.0001	0.005	0.01	0.0001	0.005	0.01
7	Heavy metals (calculated in Pb), ω/% ≤	0.001	0.001	0.005	0.001	0.001	0.005

Source: National Standard on Phosphoric Acid for Industrial Use (GB/T 2091-2008)

Industrial grade PA is mainly used in electroplating industry, fertilizer industry, inorganic chemical industry and daily chemical industry.

- It is used as a polish in the electroplating industry.
- In the fertilizer industry, it is used to manufacture ammonium phosphate, triple superphosphate, precipitated calcium phosphate, etc.
- In inorganic chemical industry, it is used in the production of various phosphates, such as acid manganese phosphate, dipotassium hydrogen phosphate, disodium phosphate, potassium pyrophosphate.
- It is used as a detergent additive in the daily chemical industry.
- It is used as a catalyst in the plastics and organic synthesis industry.

At present, there are two ways to produce industrial grade PA in China: one is thermal process, and the other is wet purification process. Chinese producers mainly use thermal process.

With the vigorous development of new energy industry, lithium iron phosphate (LFP) battery will become the mainstream for a period of time, thus driving the growth of demand for industrial grade PA. In addition, many industrial grade PA producers in China have set on the path to refine their products, shifting from traditional bulk industrial grade ones to high value-added ones such as food grade, pharmaceutical grade, and electronic grade PAs.

2 Production situation of PA in China

Most of China's PA production capacity is distributed in regions such as Yunnan, Guizhou and Hubei, where there are abundant phosphate ore resources and existing phosphate ore processing capacity.

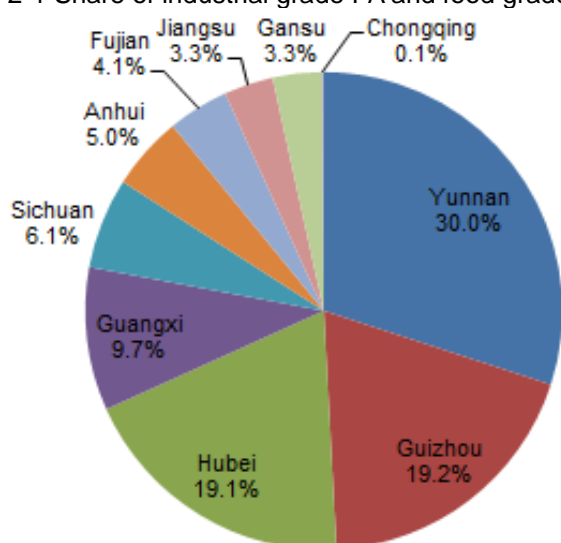
Hubei is home to 400,000 t/a PA capacity newly added in the past three years, thanks to its abundant phosphate ore resources. Guangxi also witnesses quick PA capacity expansion due to its geographical proximity to Guizhou and Yunnan, which entitles companies there to lower costs spent on obtaining phosphate ores.

Table 2-1 Capacity of industrial grade PA and food grade PA in China by region, 2020–2022

Province/region	Capacity, t/a		
	2020	2021	2022
Yunnan	2,681,000	2,693,000	2,693,000
Guizhou	1,720,000	1,720,000	1,720,000
Hubei	1,314,000	1,714,000	1,714,000
Sichuan	550,500	550,500	550,500
Anhui	450,000	450,000	450,000
Guangxi	444,000	670,000	870,000
Jiangsu	420,000	300,000	300,000
Gansu	370,000	300,000	300,000
Fujian	300,000	370,000	370,000
Chongqing	10,000	10,000	10,000

Source: CCM

Figure 2-1 Share of industrial grade PA and food grade PA capacity in China by region, 2022



Source: CCM

Food grade PA and electronic grade PA on the market are basically produced through thermal PA. Due to strict requirements for electronic grade PA, almost all electronic grade PA is thermally produced. Electronic grade PA producers generally have supporting yellow phosphorus production capacity. The production

capacity of electronic grade PA is concentrated in Guangxi, Hubei, Sichuan and Jiangsu.

From 2020 to 2022, the output of wet process PA showed an upward trend, while the output of thermal process PA showed a downward trend. In recent years, thermal PA market has been challenged by wet purification technology and impacted by restricted production capacity of yellow phosphorus. The demand for thermal PA has declined continuously, and there is a strong trend of further decline.

Table 2-2 Output proportion (industrial grade PA and food grade PA) by production process in China, 2020–2022

Item	2020	2021	2022
Output proportion of wet process PA	83.9%	85.8%	85.8%
Output proportion of thermal process PA	16.1%	14.2%	14.2%

Note: Output only includes the output of key enterprises.

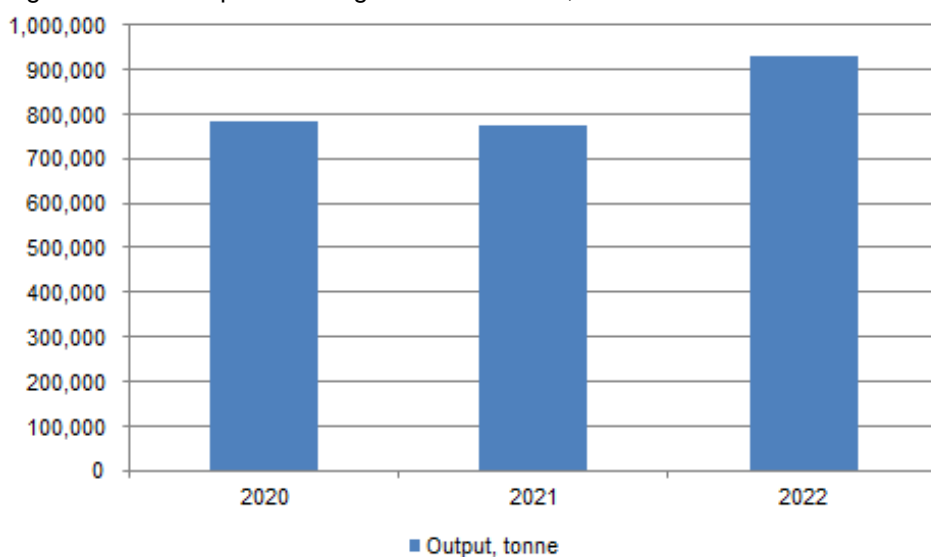
Source: CCM

2.1 Food grade PA

2.1.1 Capacity and output of food grade PA, 2020–2022

The output of food grade PA in China was 781,200 tonnes in 2020; it decreased slightly to 774,600 tonnes in 2021, mainly due to a significant reduction in Jiangsu Chengxing Phosph-Chemicals Co., Ltd. In 2022, the output jumped to 927,600 tonnes, partly due to an increase in food grade PA exports, which increased from 335,000 tonnes in 2021 to 453,000 tonnes in 2022. In the past five years, China's food grade PA exports peaked at 485,200 tonnes in 2018. Despite following contractions, the exports recovered to the 453,000 tonnes in 2022. It is expected that food grade PA exports will continue to increase in the future.

Figure 2.1.1-1 Output of food grade PA in China, 2020–2022

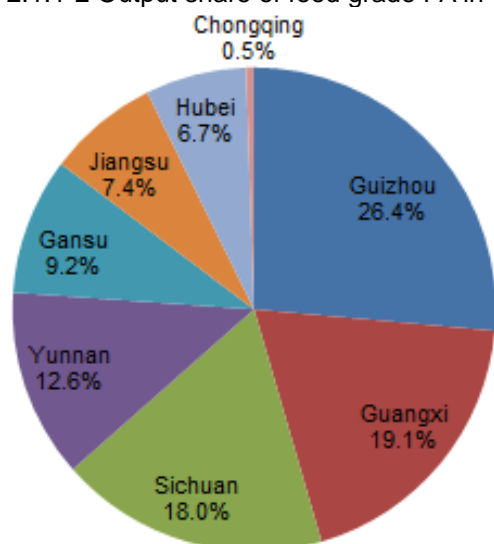


Source: CCM

The production of food grade PA in Yunnan, Guizhou, Guangxi and Sichuan provinces accounts for more than half of the national total. Yunnan, Guizhou and Sichuan provinces are rich in phosphate ore resources. Guizhou and Guangxi have better quality phosphate ores, and thus take the lead in food grade PA production. Many enterprises, such as Wengfu Group and Chongqing Chuandong, have food grade PA production bases in Guizhou. Enterprises, such as Jiangsu Chengxing and Chengjiang Dean, have established subsidiaries in Guangxi to produce food grade PA.

It can be seen that production sites of food grade PA are located close to markets of raw material phosphate ores.

Figure 2.1.1-2 Output share of food grade PA in China by region, 2022



Note: Due to rounding, the total may not equal 100.0%.
Source: CCM

2.1.2 Producers of food grade PA in China, 2020–2022

China has become the world's largest producer of food grade PA, and its food grade PA products are exported in large quantities. Most Chinese food grade PA producers have been increasing their output in recent years, as there is a trend of shifting from the production of low value added PA products to higher value added ones.

In many PA producers, food grade PA and industrial grade PA share the production equipment. At present, Jiangsu Chengxing has 250,000 t/a capacity dedicated to food grade PA production, Yuntianhua has 80,000 t/a such capacity, and Qinzhou Capital Success has 40,000 t/a capacity.

In recent years, many enterprises have begun to increase their food grade PA capacity. For example, a subsidiary of Hubei Xingfa has planned to transform its 50,000 t/a industrial grade PA lines into food grade PA lines; capacity of the food grade PA lines would eventually reach 150,000 t/a.

Table 2.1.2-1 Basic info of key manufacturers of food grade PA in China, 2020–2022

No.	Company	Abbreviation	Production site	Status		
				2020	2021	2022
1	Wengfu (Group) Co., Ltd.	Wengfu Group	Guizhou, Sichuan, Gansu	Active	Active	Active
2	Jiangsu Chengxing Phosph-Chemicals Co., Ltd.	Jiangsu Chengxing	Jiangsu, Guangxi	Active	Active	Active
3	Yunnan Yuntianhua Co., Ltd.	Yuntianhua	Yunnan	Active	Active	Active
4	Hubei Xingfa Chemicals Group Co., Ltd.	Hubei Xingfa	Hubei	Active	Active	Active
5	Kunming Chuan Jin Nuo Chemical Co., Ltd.	Kunming Chuan Jin Nuo	Yunnan, Guangxi	Active	Active	Active
6	Guangxi Qinzhou Capital Success Chemical Co., Ltd.	Qinzhou Capital Success	Guangxi	Active	Active	Active
7	Yunnan Chengjiang Dean Phosphorus Chemical Co., Ltd.	Chengjiang Dean	Yunnan, Guangxi	Active	Active	Active
8	Mianyang Aostar Phosphorus Chemical Industry Co., Ltd.	Mianyang Aostar	Sichuan	Active	Active	Active

No.	Company	Abbreviation	Production site	Status		
				2020	2021	2022
9	Yunnan Jianglin Group Co., Ltd.	Yunnan Jianglin	Yunnan	Active	Active	Active
10	Sichuan Shifang Dingli Phosphate Chemical Co., Ltd.	Shifang Dingli	Sichuan	Active	Active	Active
11	Guizhou Sino-Phos Chemical Co., Ltd.	Guizhou Sino-Phos	Guizhou	Active	Active	Active
12	Shifang Qishan Chemical Co., Ltd.	Shifang Qishan	Sichuan	Active	Active	Active
13	Chongqing Chuandong Chemical (Group) Co., Ltd.	Chongqing Chuandong	Chongqing, Guizhou	Active	Active	Active
14	SEMIAC Electronic Chemicals Co., Ltd.	SEMIAC Electronic	Sichuan	Active	Active	Active
15	Hubei Sinophorus Electronic Materials Co., Ltd.	Hubei Sinophorus	Hubei	Active	Active	Active

Source: CCM

Wengfu Group, Jiangsu Chengxing, Yuntianhua, Hubei Xingfa and Kunming Chuan Jin Nuo are the top five food grade PA producers (by output) in China.

Wengfu (Group) Co., Ltd.

Wengfu Group has PA production capacity of 1.87 million t/a, plus 1 million t/a wet process purification PA capacity. The company's food grade PA output increased from 320,000 tonnes in 2020 to 427,000 tonnes in 2022.

It is currently the largest wet process purified PA supplier in China, and 90% of the phosphate ores come from self-production. The company, headquartered in Guizhou, has food grade PA production in its plants in Guizhou, Sichuan and Gansu. Wengfu Group fully utilizes its own phosphate ore resources and technological research and development advantages. Based on imported PA extraction process, it collaborates with Tsinghua University to solve technical problems of purification and purification of wet process PA. Technology advantages have enabled the company to broaden the application of its PA products in industries with higher added value.

Jiangsu Chengxing Phosph-Chemicals Co., Ltd.

At present, Jiangsu Chengxing has yellow phosphorus production capacity of 160,000 t/a, PA production capacity of 600,000 t/a, and phosphate production capacity of 95,000 t/a. The company has a yellow phosphorus production base in Yunnan, but its product deep processing bases are located in Jiangyin of Jiangsu and Qinzhou of Guangxi. Important subsidiaries of the company include Yunnan Xuanwei Phosphorus Electricity Co., Ltd., Guangxi Qinzhou Chengxing Chemical Technology Co., Ltd. (Qinzhou Chengxing), Jiangyin Chengxing Daily Chemical Co., Ltd., and Yunnan Mile Phosphorus Electricity Co., Ltd. In particular, Qinzhou Chengxing has 250,000 t/a capacity dedicated to food grade PA production. Currently, 70% of the company's phosphate ores come from self-produced sources.

Due to production suspension of in its Jiangsu base for a period of time in 2021, its food grade PA output decreased to 95,000 tonnes in 2021. In 2022, the output recovered to 138,000 tonnes.

Yunnan Yuntianhua Co., Ltd.

Yuntianhua currently has the largest phosphate production capacity and the second largest phosphate fertilizer production capacity in China. Its PA production capacity reaches 2.27 million t/a, and production capacity for basic phosphate fertilizers is 5.55 million t/a. Yuntianhua's phosphate ores are mostly self-produced. Yuntianhua's food grade PA output increased steadily from 60,000 tonnes in 2020 to 75,000 tonnes in 2022.

Hubei Xingfa Chemicals Group Co., Ltd.

Hubei Xingfa currently has yellow phosphorus production capacity of 160,000 t/a, PA production capacity of 860,000 t/a, plus 100,000 t/a wet process purification PA production capacity. At present, most of its phosphate ores are self-produced, supported by phosphate ore production capacity of 5.85 million t/a. Its

subsidiary Yidu Xingfa Chemical Co., Ltd. mainly engages in the fertilizer business, with PA production capacity of 700,000 t/a. Hubei Xingfa's food grade PA output was 50,000 tonnes in 2020, and it maintained at 60,000 tonnes in 2021 and 2022.

Kunming Chuan Jin Nuo Chemical Co., Ltd

In 2022, Kunming Chuan Jin Nuo has PA production capacity of 390,000 t/a. The company adopts wet process to produce crude PA, and then the crude PA is further purified to produce industrial and food grade PAs.

In 2022, the company produced 100,000 tonnes of purified industrial grade PA, and put into operation 5,000 t/a iron phosphate production lines. Besides, its subsidiary Guangxi Chuan Jin Nuo Chemical Co., Ltd. has planned to construct a 100,000 t/a battery grade lithium iron phosphate project; the company is actively extending its presence to the new energy industry.

Table 2.1.2-2 Capacity and output of food grade PA in key producers in China, 2020–2022

No.	Company	Capacity, t/a			Output, tonne		
		2020	2021	2022	2020	2021	2022
1	Wengfu Group	1,870,000	1,870,000	1,870,000	320,000	330,000	427,000
2	Jiangsu Chengxing	720,000	600,000	600,000	157,000	95,000	138,000
3	Yuntianhua	2,270,000	2,270,000	2,270,000	60,000	70,000	75,000
4	Hubei Xingfa	460,000	860,000	860,000	50,000	60,000	60,000
5	Kunming Chuan Jin Nuo	190,000	390,000	390,000	50,000	60,000	60,000
6	Qinzhou Capital Success	40,000	40,000	40,000	36,000	37,000	38,000
7	Chengjiang Dean	89,000	115,000	115,000	28,000	32,000	37,000
8	Mianyang Aostar	46,000	46,000	46,000	23,000	23,000	23,000
9	Yunnan Jianglin	30,000	42,000	42,000	10,000	13,500	15,000
10	Shifang Dingli	36,500	36,500	36,500	10,000	14,000	15,000
11	Guizhou Sino-Phos	30,000	30,000	30,000	16,500	15,000	15,000
12	Shifang Qishan	20,000	20,000	20,000	7,500	9,000	10,500
13	Chongqing Chuandong	150,000	150,000	150,000	7,000	8,000	7,000
14	SEMIAC Electronic	18,000	18,000	18,000	4,500	4,500	4,500
15	Hubei Sinophorus	30,000	30,000	30,000	1,700	3,600	2,600

Note: The capacity includes food grade PA capacity and industrial grade PA capacity.

Source: CCM

Except Wengfu Group and Kunming Chuan Jin Nuo, which only use wet process to produce food grade PA, most domestic companies use thermal process to produce food grade PA. Wide application of thermal process in the production is also attributed to the immature wet process PA purification technology in China, with only a few companies now mastering the technology.

Generally speaking, thermal process PA has better quality than wet process PA and thus it can produce food grade PA directly. Yet restricted by yellow phosphorus capacity, the output of thermal process PA will decrease in the future. At present, there are enterprises that produce food grade PA by purifying wet process

PA, such as Wengfu Group. Hubei Xingfa will apply purification technology and upgrade some industrial grade PA equipment to produce food grade PA. In the future, more companies will enhance their competitiveness by purchasing purification technologies or self-developing purification technologies.

Table 2.1.2-3 Production technology adopted in food grade PA producers in China

No.	Company	Technology
1	Wengfu Group	Wet process
2	Jiangsu Chengxing	Thermal process
3	Yuntianhua	Wet process, thermal process
4	Hubei Xingfa	Wet process, thermal process
5	Kunming Chuan Jin Nuo	Wet process
6	Qinzhou Capital Success	Thermal process
7	Chengjiang Dean	Thermal process
8	Mianyang Aostar	Thermal process
9	Yunnan Jianglin	Thermal process
10	Shifang Dingli	Wet process, thermal process
11	Guizhou Sino-Phos	Thermal process
12	Shifang Qishan	Thermal process
13	Chongqing Chuandong	Wet process, thermal process
14	SEMIAC Electronic	Thermal process
15	Hubei Sinophorus	Thermal process

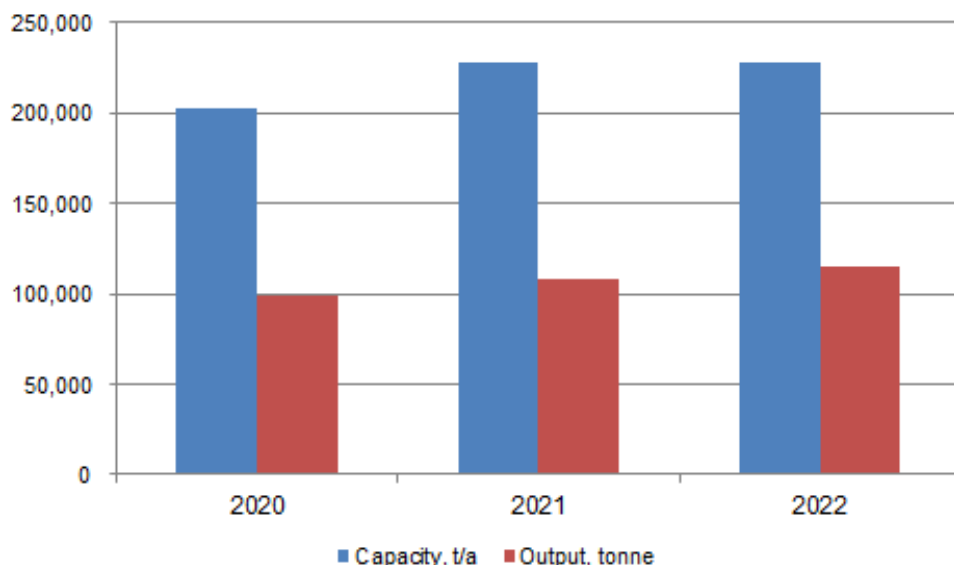
Source: CCM

2.2 Electronic grade PA

2.2.1 Capacity and output of electronic grade PA, 2020–2022

In China, the production capacity of electronic grade PA grew from 202,000 t/a in 2020 to 228,000 t/a in 2022, and the output increased year by year during this period.

Figure 2.2.1-1 Capacity and output of electronic grade PA in China, 2020–2022

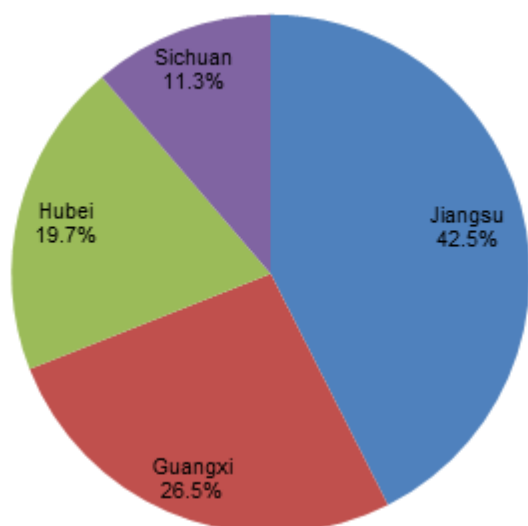


Source: CCM

China's production of electronic grade PA is concentrated in Jiangsu and Guangxi. Jiangsu Chengxing produces electronic grade PA in both Guangxi and Jiangsu. Chengjiang Dean has a subsidiary in Guangxi to produce electronic grade PA.

Guangxi boasts phosphate ores of good quality, and electronic grade PA manufacturers there can enjoy cheaper hydropower. Jiangsu sits close to downstream markets of electronic grade PA. Compared with the production of food grade and industrial grade PAs, the production of electronic grade PA needs to be closer to downstream markets.

Figure 2.2.1-2 Output share of electronic grade PA in China by region, 2022



Source: CCM

2.2.2 Producers of electronic grade PA in China, 2020–2022

At present, there are not many electronic grade PA manufacturers in China. Of the existing Chinese electronic grade PA manufacturers, Hubei Sinophorus can produce products that reach E2 level, and the overall quality of its products is regarded advanced at the international level. With rapid development of

China's semiconductor integrated circuit industry, domestic demand for electronic grade PA has grown fast, and Chinese electronic grade PA manufacturers have begun to increase their output.

Due to strict requirements for electronic grade PA production, almost all electronic grade PA is produced through thermal process in China. These electronic grade PA manufacturers generally have supporting production capacity for yellow phosphorus.

Table 2.2.2-1 Basic info of key manufacturers of electronic grade PA in China, 2020–2022

No.	Company	Abbreviation	Production site	Status		
				2020	2021	2022
1	Jiangsu Chengxing Phosph-Chemicals Co., Ltd.	Jiangsu Chengxing	Jiangsu	Active	Active	Active
2	Hubei Sinophorus Electronic Materials Co., Ltd.	Hubei Sinophorus	Hubei	Active	Active	Active
3	Yunnan Chengjiang Dean Phosphorus Chemical Co., Ltd.	Chengjiang Dean	Guangxi	Active	Active	Active
4	Guangxi Qinzhou Capital Success Chemical Co., Ltd.	Qinzhou Capital Success	Guangxi	Active	Active	Active
5	SEMIAC Electronic Chemicals Co., Ltd.	SEMIAC Electronic	Sichuan	Active	Active	Active
6	Yunphos (Taixing) Chemical Co., Ltd.	Taixing Yunphos	Jiangsu	Active	Active	Active

Note: Hubei Sinophorus Electronic Materials Co., Ltd. is a subsidiary of Hubei Xingfa Chemicals Group Co., Ltd.
Source: CCM

Table 2.2.2-2 Capacity and output of key electronic grade PA manufacturers in China, 2020–2022

No.	Company	Capacity, t/a			Output, tonne		
		2020	2021	2022	2020	2021	2022
1	Jiangsu Chengxing	50,000	50,000	50,000	42,000	41,000	43,000
2	Hubei Sinophorus	30,000	30,000	30,000	16,400	19,500	22,700
3	Chengjiang Dean	54,000	80,000	80,000	23,000	25,000	29,000
4	Qinzhou Capital Success	40,000	40,000	40,000	1,000	1,200	1,500
5	SEMIAC Electronic	18,000	18,000	18,000	10,500	12,000	13,000
6	Taixing Yunphos	10,000	10,000	10,000	6,000	9,000	6,000

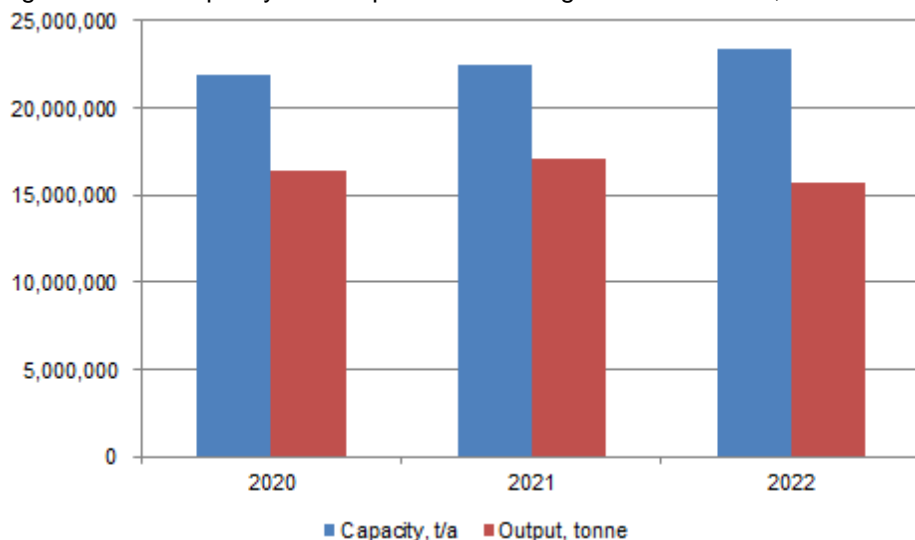
Note: The output is for electronic grade PA only, while the capacity is not for electronic grade PA only.
Source: CCM

2.3 Industrial grade PA

2.3.1 Capacity and output of industrial grade PA, 2020–2022

From 2020 to 2021, the output of industrial grade PA in China increased from some 16,347,000 tonnes to about 17,071,000 tonnes. In 2022, the output decreased to 15,671,000 tonnes, mainly due to a decrease in the output of PA for phosphate fertilizers.

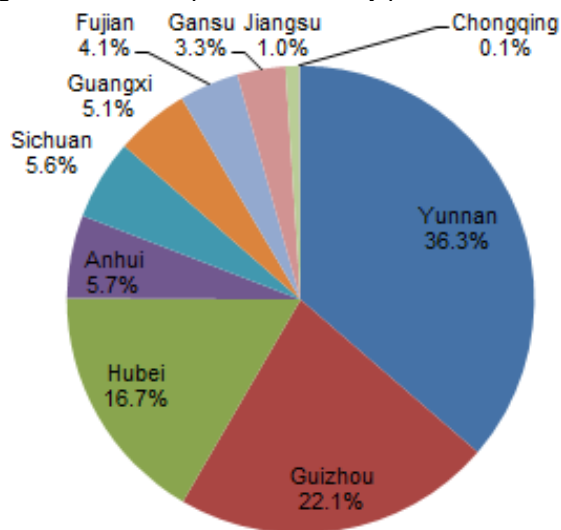
Figure 2.3.1-1 Capacity and output of industrial grade PA in China, 2020–2022



Source: CCM

The abundant phosphorus ore resources in Yunnan, Guizhou and Hubei make it unsurprising that industrial grade PA production in these regions is larger than in other regions. At the same time, PA production also expand to surrounding areas, with some enterprises producing low value-added products in phosphate rich areas and producing high value-added products in other areas.

Figure 2.3.1-2 Output share of key producers of industrial grade PA in China by region, 2022



Source: CCM

2.3.2 Producers of industrial grade PA in China, 2020–2022

- Industrial grade PA

Table 2.3.2-1 Basic info of key industrial grade PA manufacturers in China, 2020–2022

No.	Company	Abbreviation	Production site	Status		
				2020	2021	2022
1	Yunnan Yuntianhua Co., Ltd.	Yuntianhua	Yunnan	Active	Active	Active
2	Wengfu (Group) Co., Ltd.	Wengfu Group	Guizhou, Sichuan, Fujian, Gansu	Active	Active	Active
3	Guizhou Kailin Group Co., Ltd.	Guizhou Kailin	Guizhou	Active	Active	Active
4	Anhui Liuguo Chemical Co., Ltd.	Anhui Liuguo	Anhui, Hubei	Active	Active	Active
5	Hubei Yihua Chemical Industry Co., Ltd.	Hubei Yihua	Hubei	Active	Active	Active
6	Hubei Xingfa Chemicals Group Co., Ltd.	Hubei Xingfa	Hubei	Active	Active	Active
7	Guizhou Chanhen Chemical Corporation	Guizhou Chanhen	Guizhou, Guangxi, Sichuan	Active	Active	Active
8	Kunming Chuan Jin Nuo Chemical Co., Ltd.	Kunming Chuan Jin Nuo	Yunnan, Guangxi	Active	Active	Active
9	Chongqing Chuandong Chemical (Group) Co., Ltd.	Chongqing Chuandong	Chongqing, Guizhou, Guangxi	Active	Active	Active
10	Jiangsu Chengxing Phosph-Chemicals Co., Ltd.	Jiangsu Chengxing	Jiangsu, Guangxi	Active	Active	Active
11	Yunnan Chengjiang Dean Phosphorus Chemical Co., Ltd.	Chengjiang Dean	Yunnan, Guangxi	Active	Active	Active
12	Mianyang Aostar Phosphorus Chemical Industry Co., Ltd.	Mianyang Aostar	Sichuan	Active	Active	Active
13	Xiangyang Gaolong Phosphorus Chemical Co., Ltd.	Xiangyang Gaolong	Hubei	Active	Active	Active
14	Yunnan Jianglin Group Co., Ltd.	Yunnan Jianglin	Yunnan	Active	Active	Active
15	Sichuan Shifang Dingli Phosphate Chemical Co., Ltd.	Shifang Dingli	Sichuan	Active	Active	Active
16	Guizhou Sino-Phos Chemical Co., Ltd.	Guizhou Sino-Phos	Guizhou	Active	Active	Active
17	Shifang Qishan Chemical Co., Ltd.	Shifang Qishan	Sichuan	Active	Active	Active

Source: CCM

Of the key industrial grade PA manufacturers in China, Yuntianhua has the largest industrial grade PA production, and Wengfu Group ranks second. For enterprises with large PA production capacity, they generally achieve high self-sufficiency rate of phosphate ores. These companies also produce phosphate fertilizers, for which most of their industrial grade PA is used. Yuntianhua, Wengfu Group and Anhui Liuguo are typical representatives of such companies.

Yunnan Yuntianhua Co., Ltd.

In the past three years, Yuntianhua maintained its PA production capacity at 2.27 million t/a, and its output of industrial grade PA hovered around 1.94 million tonnes.

The company currently has the largest phosphate production capacity and the second largest phosphate

fertilizer production capacity in China. Its production capacity for basic phosphate fertilizers is 5.55 million t/a. It is also the largest phosphate ore mining and beneficiation enterprise in China.

Wengfu (Group) Co., Ltd.

With PA production capacity maintained at 1.87 million t/a in the past three years, Wengfu Group had an output of industrial grade PA of 1.16 million tonnes in 2022, down from the 1.33 million tonnes achieved in 2021. The group has four major industrial grade PA production bases: the core base in Guizhou, Jinchang base in Gansu, Dazhou base in Sichuan, and Shanghang base in Fujian.

Guizhou Kailin Group Co., Ltd.

Guizhou Kailin has a unique advantage in resources, with a total amount of 654 million tonnes of phosphate ore resources and proven reserves of 413 million tonnes. Its phosphate ores can be directly used for the production of high concentration phosphate compound fertilizers without mineral processing. At present, Guizhou Kailin has PA production capacity of 600,000 t/a, and its output of industrial grade PA kept at 550,000 tonnes in 2021 and 2022.

Anhui Liuguo Chemical Co., Ltd.

Anhui Liuguo currently has three sets of wet process PA production lines, multiple sets of monoammonium phosphate, diammonium phosphate, and compound fertilizer production lines. The technologies it adopts in the production of wet process PA and phosphate compound fertilizer are relatively advanced. Since the company does not own mining rights for phosphate ores, it mainly relies on phosphate ore procurement from areas in the upper reaches of the Yangtze River.

PA production capacity at the company's headquarter base is 400,000 t/a, its subsidiary Tongling Sinco Fine Chemical Co., Ltd. has 50,000 t/a PA capacity and another subsidiary Hubei Liuguo Chemical Co., Ltd. has 200,000 t/a PA capacity. It has localized wet process PA purification technology, and the PA thus produced can be used to produce iron phosphate.

To avoid being eliminated by the market, the company has accelerated the transformation and upgrading to extend its industrial chain to the fine chemical industry. In September 2022, Hubei Huiyang New Materials Co., Ltd. was established; the company has planned to construct a 280,000 t/a battery grade refined PA project.

Hubei Yihua Chemical Industry Co., Ltd.

Hubei Yihua currently has PA production capacity of 600,000 t/a and wet process purification PA capacity of 200,000 t/a. Some 60% of the company's phosphate ores are self-produced. In the past three years, its industrial grade PA output maintained at 400,000 tonnes.

Table 2.3.2-2 Capacity and output of industrial grade PA in key producers in China, 2020–2022

No.	Company	Capacity, t/a			Output, tonne		
		2020	2021	2022	2020	2021	2022
1	Yuntianhua	2,270,000	2,270,000	2,270,000	1,940,000	1,950,000	1,925,000
2	Wengfu Group	1,870,000	1,870,000	1,870,000	1,280,000	1,330,000	1,160,000
3	Guizhou Kailin	600,000	600,000	600,000	500,000	550,000	550,000
4	Anhui Liuguo	650,000	650,000	650,000	450,000	460,000	470,000
5	Hubei Yihua	600,000	600,000	600,000	400,000	400,000	400,000
6	Hubei Xingfa	460,000	860,000	860,000	337,000	376,000	361,000
7	Guizhou Chanhen	230,000	230,000	430,000	100,000	100,000	200,000
8	Kunming Chuan Jin Nuo	190,000	390,000	390,000	150,000	140,000	140,000
9	Chongqing Chuandong	150,000	150,000	150,000	130,000	130,000	130,000
10	Jiangsu Chengxing	720,000	600,000	600,000	177,000	94,000	108,000
11	Chengjiang Dean	89,000	115,000	115,000	40,000	40,000	40,000
12	Mianyang Aostar	46,000	46,000	46,000	23,000	23,000	23,000
13	Xiangyang Gaolong	24,000	24,000	24,000	20,000	20,000	20,000
14	Yunnan Jianglin	30,000	42,000	42,000	15,000	16,000	15,000
15	Shifang Dingli	36,500	36,500	36,500	15,000	14,000	15,000
16	Guizhou Sino-Phos	30,000	30,000	30,000	13,000	15,000	15,000
17	Shifang Qishan	20,000	20,000	20,000	7,000	6,000	4,000

Note: 1. The capacity includes food grade PA capacity and industrial grade PA capacity.

2. The output of industrial grade PA includes that of fertilizer PA.

Source: CCM

For industrial grade PA, wet process is widely adopted in the production, as requirements for industrial grade PA are not as high as those for food grade and electronic grade PAs. The industrial grade PA here in this report includes PA used for phosphate fertilizers, which has lower quality requirements and is often produced through wet process technology. PA producers, such as Yuntianhua, Wengfu Group and Guizhou Kailin, produce a large volume of fertilizer PA.

Table 2.3.2-3 Production technology adopted in major industrial grade PA producers in China

No.	Company	Technology
1	Yuntianhua	Wet process, thermal process
2	Wengfu Group	Wet process
3	Guizhou Kailin	Wet process
4	Anhui Liuguo	Wet process
5	Hubei Yihua	Wet process
6	Hubei Xingfa	Wet process, thermal process
7	Guizhou Chanhen	Wet process
8	Kunming Chuan Jin Nuo	Wet process
9	Chongqing Chuandong	Wet process, thermal process
10	Jiangsu Chengxing	Thermal process
11	Chengjiang Dean	Thermal process
12	Mianyang Aostar	Thermal process
13	Xiangyang Gaolong	Thermal process
14	Yunnan Jianglin	Thermal process
15	Shifang Dingli	Wet process, thermal process
16	Guizhou Sino-Phos	Thermal process
17	Shifang Qishan	Thermal process

Source: CCM

- Industrial grade PA with phosphate fertilizer enterprises

Phosphate fertilizer enterprises can be divided into two categories:

- The ones that only produce phosphate fertilizer products, and the PA they produce is generally used for the production of phosphate fertilizers;
- The ones that have wet process purified PA capacity or plan to build such capacity. These phosphate fertilizer enterprises are no longer limited to the production of low value-added products; in fact, they actively promote industrial upgrading and seek transformation. Among these enterprises, some have already built up iron phosphate capacity, and some others have revealed plans to build iron phosphate production capacity.

For enterprises that only produce phosphate fertilizers, such as Hubei Dayukou Chemical Co., Ltd. and Yunnan Xiangfeng Industrial Group Co., Ltd., their level of forward integration is low in general, and such enterprises are likely to lose market share in the fierce competitive environment in the future.

Some phosphate fertilizer enterprises, like Wengfu Group, no longer solely produce low value-added products such as phosphate fertilizers. Instead, they have begun to produce higher value-added products such as food grade PA. These enterprises are gradually deepening their forward integration. Most of such kind of phosphate fertilizer enterprises have their own phosphate mines, and they also have applied certain wet process PA purification technologies. In the future, these enterprises will have greater advantages in adjusting their product structure. Some others, such as Chengdu Wintrue Holding Co., Ltd. and Sinochem

Fuling Chongqing Chemical Industry Co., Ltd., have had refined PA production capacity and are beginning to shift from low value-added phosphate fertilizers to high value-added PA products.

Some enterprises, such as Xinyangfeng Agricultural Technology Co., Ltd., Kingenta Norsterra Chemical Co., Ltd., and Hubei Harvin (Group) Chemical Co., Ltd., though they do not have refined PA production capacity at present, have revealed plans to construct refined PA projects and are preparing for industrial transformation.

Table 2.3.2-4 Representative PA producers of industrial grade PA with phosphate fertilizers

Type of producer	Representative producer	PA Capacity 2022, t/a
Phosphate fertilizer-only	Hubei Dayukou Chemical Co., Ltd.	400,000
	Yunnan Xiangfeng Industrial Group Co., Ltd.	400,000
Phosphate fertilizer plus purified PA	Yunnan Yuntianhua Co., Ltd.	2,270,000
	Wengfu (Group) Co., Ltd.	1,870,000
	Sichuan Development Lomon Co., Ltd.	1,300,000
	Chengdu Wintrue Holding Co., Ltd.	890,000
	Xinyangfeng Agricultural Technology Co., Ltd.	700,000
	Hubei Sanning Chemical Co., Ltd.	800,000
	Hubei Liuguo Chemical Co., Ltd.	650,000
	Hubei Yihua Group Co., Ltd.	600,000
	Guizhou Kailin Group Co., Ltd.	600,000
	Hubei Harvin (Group) Chemical Co., Ltd.	600,000
	Anhui Sierte Fertilizer Industry Co., Ltd.	450,000
	Sinochem Fuling Chongqing Chemical Industry Co., Ltd.	400,000
	Kingenta Norsterra Chemical Co., Ltd.	300,000
	Stanley Agriculture Group Co., Ltd.	300,000

*Note: Main products of these enterprises are phosphate fertilizers. PA produced in these enterprises is mainly for self use.
Source: CCM*

2.4 Domestic PA expansion project, 2020–2023

It can be seen that most of the new PA projects proposed from 2020 onward adopt wet process, which is also in line with China's policy trend. However, the current wet process PA purification technology in China is not mature enough, so some enterprises have launched thermal PA projects for the production of electronic grade and food grade PAs. At present, some enterprises that have mastered wet process PA purification technology are increasing their wet process purified PA production capacity.

Some enterprises whose main products are phosphate fertilizers have also begun to adjust their industrial structure and add purified PA production capacity. For some enterprises, this is a strategic arrangement to further improve their integrated mining-chemical industrial chain.

Most of the new industrial grade PA projects are to support the development of lithium iron phosphate projects in these enterprises. Most of the new food grade and electronic grade PA projects serve the purposes to adjust company industrial structure, promote industrial upgrading, and shift the products from low value-added ones to high value-added ones.

Table 2.4-1 Phosphoric acid expansion projects in China, 2020–Aug. 2023

No.	Company	Project location	Designed capacity	Reason for the construction	Year of launching production	Type	Note	PA production process
1	Guizhou Kailin Group Co., Ltd.	Guiyang City, Guizhou Province	400,000 t/a Industrial grade and food grade purified PA	To promote industrial structure adjustment, transformation and upgrading.	2023	Industrial grade PA, food grade PA	The project had been completed by July 2023 and qualified products have been produced.	Wet process
2	Guangxi Qinzhou Capital Success Chemical Co., Ltd.	Qinzhou City, Guangxi Zhuang Autonomous Region	50,000 t/a PA	To meet the needs of the national development plan for the Beibu Gulf, fully utilize policy and market advantages to improve product quality and develop the company's industrial chains of PA and petrochemical products.	2023	Food grade PA	The production equipment of this project can not only produce standard food grade PA, but also produce PA with purity higher than the food additive standard required. On March 30, 2023, news came that the company's renovated PA production lines with total capacity of 90,000 t/a were successfully put into operation.	Thermal process
3	Guizhou Fuquan Chuandong Chemical Co., Ltd.	Fuquan City, Guizhou Province	90,000 t/a Industrial grade PA (using self-produced yellow phosphorus) and 25,000 t/a yellow phosphorus	To extend yellow phosphorus deep-processing industrial chain, gradually fill the gap in the yellow phosphorus post processing industry within the province, and improve the yellow phosphorus post processing industry system.	2025	Industrial grade PA	/	Thermal process
4	Guangxi Liucheng Chuandong Phosphorus Chemical Co., Ltd.	Liuzhou City, Guangxi Zhuang Autonomous Region	50,000 t/a Food grade PA and 50,000 t/a electronic grade PA	Food grade PA: to increase the company's adaptability to the market. Electronic grade PA: to seize the opportunities offered with the vigorous development of chip industry and new energy battery industry in China, and the growing market demand for high-purity PA.	2023	Food grade PA, electronic grade PA	The construction of food grade PA lines and supporting facilities have been completed, and the equipment has been installed and put to commissioning, but not put into production yet; the lines will be put into production in 2023. As regards electronic grade PA lines, according to the company's plan, the construction should start in February 2023 and be completed and put into operation in July 2023.	Thermal process
5	Guizhou Hengchang New Energy Materials Co., Ltd.	Weng'an County, Guizhou Province	300,000 t/a Hemihydrate wet PA, 200,000 t/a food grade purified PA	To expand the company's overall strengths.	2025	Industrial grade PA, food grade PA	The company is a holding subsidiary of Guizhou Hengda Mining Holdings Co., Ltd. And Guizhou Hengda is a joint venture between Guizhou Chanhen Chemical Corporation and Sunwoda Electronic Co., Ltd.	Wet process
6	Guizhou Chanhen Chemical Corporation	Fuquan City, Guizhou Province	150,000 t/a Hemihydrate wet PA, 120,000 t/a food grade purified PA	To further improve the company's mining-chemical integration industrial chain.	2024	Industrial grade PA, food grade PA	/	Wet process
7	Guizhou Chanhen Chemical Corporation	Fuquan City, Guizhou Province	100,000 t/a Food grade purified PA, 158,797.0245 t/a industrial grade purified PA (extracted residual acid)	To promote industrial structure adjustment.	2024	Food grade PA, industrial grade PA	Raw materials for this food purified PA project come from the company's existing equipment (330,000 t/a feed grade MCP); it will consume 143,360 tonnes of hemihydrate PA (P2O5 content at about 40%).	Wet process

No.	Company	Project location	Designed capacity	Reason for the construction	Year of launching production	Type	Note	PA production process
8	Kunming Chuan Jin Nuo Chemical Co., Ltd.	Kunming City, Yunnan Province	2,500 t/a Battery-grade PA (100% P2O5) and 5,000 t/a battery-grade lithium iron phosphate precursor	To cope with the increasing demand for lithium iron phosphate.	2023	Industrial grade PA	The company will use self-produced PA as a raw material to produce battery-grade PA. According to its 2022 annual report, the project had not been completed yet.	Wet process
9	Kingenta Norsterra Chemical Co., Ltd.	Weng'an County, Guizhou Province	100,000 t/a Purified PA, 200,000 t/a PA and 400,000 t/a ammonium dihydrogen phosphate for batteries	To cope with the surging demand for energy storage materials.	2025	Industrial grade PA	/	Wet process
10	Hubei Huiyang New Materials Co., Ltd.	Dangyang City, Hubei Province	300,000 t/a P2O5 hemihydrate-dihydrate wet PA	To transform on the basis of the existing foundation of Hubei Liuguo Chemical Co., Ltd., and pursue high-end, green, smart and high-quality development.	2024	Industrial grade PA	The company is a subsidiary of Anhui Liuguo Chemical Co., Ltd.	Wet process
11	Hubei Huiyang New Materials Co., Ltd.	Dangyang City, Hubei Province	280,000 t/a 85% Wet purified PA	To promote the transformation and further development of the phosphorus chemical business.	2024	Industrial grade PA	Raw material for this project comes from the "300,000 t/a Green low-carbon wet process PA and supporting facilities project".	Wet process
12	Hubei Harvin (Group) Chemical Co., Ltd.	Wuxue City, Hubei Province	400,000 t/a Purified PA (at two phases), 80,000 t/a food grade PA	To promote industrial structure adjustment.	2025	Industrial grade PA, food grade PA	/	Wet process
13	Guizhou Xintianxin Chemical Co., Ltd.	Guiyang City, Guizhou Province	90,000 t/a Battery-grade PA, food grade PA, polyphosphate	To promote industrial upgrading.	2024	Industrial grade PA, food grade PA	/	Thermal process
14	Yichang Xinyangfeng Fertilizer Co., Ltd.	Yidu City, Hubei Province	200,000 t/a Refined PA	To adjust industrial structure and improve competitiveness.	2024	Industrial grade PA	/	Wet process
15	Yidu Xingfa Chemical Co., Ltd.	Yidu City, Hubei Province	Phase I: transform existing 50,000 t/a industrial grade PA into 50,000 t/a food grade PA. Phase II: expand the transformed 100,000 t/a food grade PA to 150,000 t/a food grade PA.	To adjust industrial structure.	2024	Food grade PA	/	Wet process
16	Hubei Sinophorus Electronic Materials Co., Ltd.	Yichang City, Hubei Province	30,000 t/a Electronic grade PA	To meet the increasing demand for electronic grade PA.	2024	Electronic grade PA	/	Thermal process

Source: CCM

3 Upstream industry of PA

3.1 Industrial grade PA and food grade PA

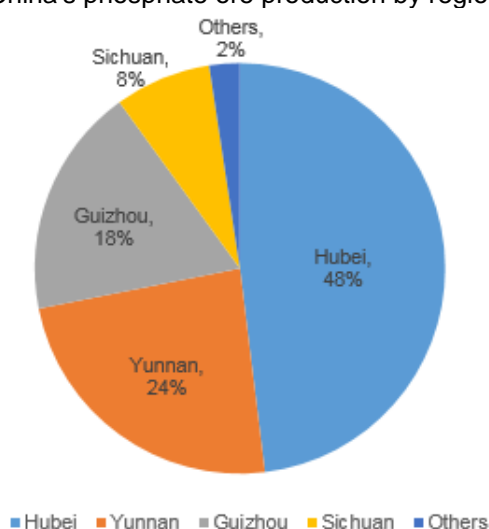
The backward integration of Chinese PA producers was deepening from 2018 to 2022. That was because, on the one hand, some of the producers who own phosphate mines added new phosphate ore capacity to improve their phosphate ore self-sufficiency rate; on the other hand, due to the rising market price of phosphate ore, producers intended to lower production costs by cutting their purchases of phosphate ore.

- Distribution of phosphate ore reserves in China

Statistics from the National Bureau of Statistics show China has 3.24 billion tonnes basic phosphate ore reserves at present, and proven phosphate ore resources are distributed in 27 provinces/autonomous regions. Notably, the distribution of phosphate ore reserves is mainly concentrated in four provinces, Hubei, Sichuan, Guizhou and Yunnan, and their combined phosphate ore reserve accounts for more than 80% of the country's total.

In 2022, China's phosphate ore production reached 104.75 million tonnes, of which 50.34 million tonnes was from Hubei, 24.93 million tonnes from Yunnan, 19.02 million tonnes from Guizhou and 7.94 million tonnes from Sichuan, together representing 98% of China's total output.

Figure 3.1-1 China's phosphate ore production by region, 2022



Source: CCM

- PA produced by different methods using different grades of phosphate ore

In China, there are not a lot of high-grade phosphate ores. More than 90% of phosphate ore in China is medium- and low-grade. PA can be commercially produced by two methods: thermal process and wet process. The thermal process has lower requirements for the quality of phosphate ore and the obtained PA is of higher purity and better quality. But the shortcomings are high energy consumption and high production costs. While the wet process, which is simple in operation and consumes less energy, uses high-grade phosphate ore as the raw material. But the cons are that the wet process PA contains more impurities and it needs to be further purified to obtain high-quality PA.

Among the industrial and food grade PA producers, nine producers have their own phosphate ore resources: Wengfu Group, Guizhou Kailin, Guizhou Chanhen, Yuntianhua, Hubei Xingfa, Hubei Yihua, Jiangsu Chengxing, Chongqing Chuandong and Yunnan Jianglin. Usually, these producers will first use their own phosphate ore to produce PA. But they will also purchase some phosphate ore from suppliers if different grades of phosphate ore are needed, or when the price of phosphate ore falls to a low level, so as to make good use of the phosphate ore resources.

PA producers usually purchase phosphate ores mined nearby. High-grade phosphate ore is mainly concentrated in Guizhou, Yunnan and Hubei provinces where wet process PA producers buy their raw material. While thermal process PA producers also purchase phosphate ore from other provinces, or they buy yellow phosphorus to make PA. Four producers including Qinzhou Capital Success, Guizhou Sino-Phos,

Shifang Qishan and SEMIAC Electronic purchase yellow phosphorus to produce PA.

Table 3.1-1 Source of phosphate ore for industrial and food grade PA producers by wet method

No.	Manufacturer	Abbreviation	Location	Upstream material self-sufficiency rate					Phosphate ores mainly sourced from
				2018	2019	2020	2021	2022	
1	Wengfu (Group) Co., Ltd.	Wengfu Group	Guizhou, Sichuan, Fujian, Gansu	80%	80%	80%	90%	94%	Guizhou
2	Guizhou Kailin Group Co., Ltd.	Guizhou Kailin	Guizhou	90%	90%	90%	90%	95%	Guizhou
3	Guizhou Chanhen Chemical Corporation	Guizhou Chanhen	Guizhou, Sichuan, Guangxi	0%	13%	50%	95%	100%	Guizhou
4	Yunnan Yuntianhua Co., Ltd.	Yuntianhua	Yunnan	90%	90%	85%	90%	95%	Yunnan
5	Hubei Xingfa Chemicals Group Co., Ltd.	Hubei Xingfa	Hubei	50%	50%	60%	20%	40%	Hubei
6	Hubei Yihua Chemical Industry Co., Ltd.	Hubei Yihua	Hubei	90%	90%	90%	90%	90%	Hubei
7	Kunming Chuan Jin Nuo Chemical Co., Ltd.	Kunming Chuan Jin Nuo	Yunnan, Guangxi	0%	0%	0%	0%	0%	Yunnan, Guizhou, Sichuan
8	Anhui Liuguo Chemical Co., Ltd.	Anhui Liuguo	Anhui, Hubei	0%	0%	0%	0%	0%	Guizhou, Hubei
9	Sichuan Shifang Dingli Phosphate Chemical Co., Ltd.	Shifang Dingli	Sichuan	0%	0%	0%	0%	0%	Sichuan

Note: Yuntianhua, Hubei Xingfa and Shifang Dingli can produce phosphoric acid through both wet and thermal methods, but mainly through wet method.

Source: CCM

Table 3.1-2 Source of phosphate ore for industrial and food grade PA producers by thermal method

No.	Manufacturer	Abbreviation	Location	Upstream material self-sufficiency rate					Phosphate ores mainly sourced from
				2018	2019	2020	2021	2022	
1	Jiangsu Chengxing Phosph-Chemicals Co., Ltd.	Jiangsu Chengxing	Jiangsu, Guangxi	60%	60%	70%	70%	70%	Yunnan
2	Chongqing Chuandong Chemical (Group) Co., Ltd.	Chongqing Chuandong	Chongqing, Guizhou, Guangxi	50%	50%	50%	60%	60%	Guizhou
3	Yunnan Jianglin Group Co., Ltd.	Yunnan Jianglin	Yunnan	40%	40%	40%	50%	50%	Yunnan
4	Mianyang Aostar Phosphorus Chemical Industry Co., Ltd.	Mianyang Aostar	Sichuan	0%	0%	0%	0%	0%	Sichuan
5	Yunnan Chengjiang Dean Phosphorus Chemical Co., Ltd.	Chengjiang Dean	Yunnan, Guangxi	0%	0%	0%	0%	0%	Yunnan
6	Xiangyang Gaolong Phosphorus Chemical Co., Ltd.	Xiangyang Gaolong	Hubei	0%	0%	0%	0%	0%	Hubei

Note: Jiangsu Chengxing has a yellow phosphorus production base in Yunnan.

Source: CCM

3.2 Electronic grade PA

At present, electronic grade PA is mainly produced from yellow phosphorus by the thermal process.

Hubei Sinophorus Electronic Materials Co., Ltd. purchases yellow phosphorus from its parent company, Hubei Xingfa Chemicals Group Co., Ltd.

Yunnan Chengjiang Dean Phosphorus Chemical Co., Ltd., Yunnan South Phosphorus Group Co., Ltd., Guangxi Qinzhou Capital Success Chemical Co., Ltd. and SEMIAC Electronic Chemicals Co., Ltd. purchase yellow phosphorus from Yunnan and Sichuan provinces.

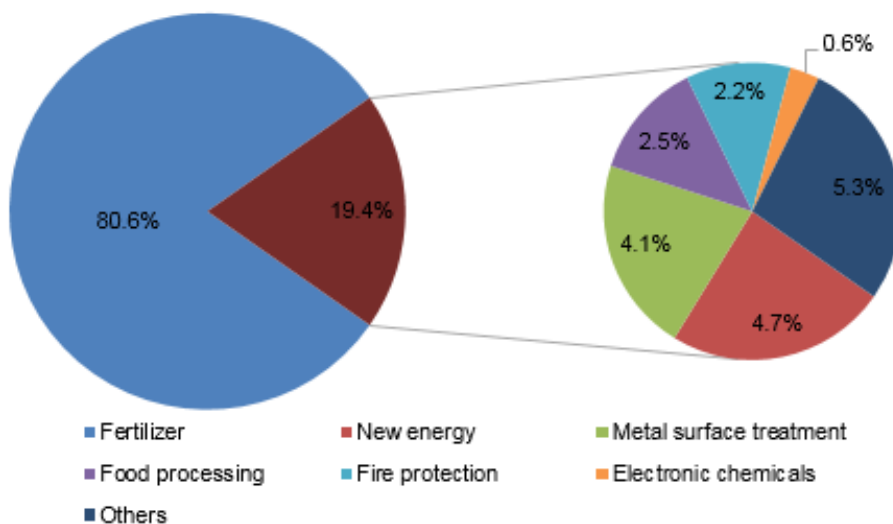
Jiangsu Chengxing Phosphorus Chemical Co., Ltd. uses its own phosphate ore resources to prepare yellow phosphorus which is then used in the production of thermal process PA. Then, the obtained PA is further refined into electronic grade PA.

4 Consumption situation of PA

China's total consumption of PA came in at 16.7 million tonnes in 2022, about 80.6% for phosphate fertilizer production and the rest of about 19.4% for new energy, metal surface treatment, food processing, fire protection, electronic chemicals and other fields.

In the non-phosphate fertilizer consumption, the new energy sector drove the increased consumption of PA and overtook the metal surface treatment sector to be the largest consumption field of PA in 2022 due to the burgeoning development of lithium iron phosphate.

Figure 4-1 Consumption of PA industry in China, 2022



Note: Other fields include feed, chemical, metallurgy, medicine and other industries.

Source: CCM

PA companies are not only extending their reach to the upstream sectors but also to the downstream sectors, especially the wet process PA producers who principally engage in the phosphate fertilizer business. Their business model is moving from "phosphate ore–PA–phosphate fertilizer" towards "phosphate ore–PA–phosphate fertilizer/phosphate", indicating the volume of self-used PA is taking a bigger share.

In addition, as the domestic extraction and purification technology of wet process PA progress, the production of purified PA (PPA) is increasing. Producers use PPA to produce fine phosphate products or sell PPA. Moreover, more downstream phosphate producers intend to purchase the lower-priced PPA instead of the thermal process PA, so as to control their production costs.

Table 4-1 PA producers' downstream products, PPA production, shares of PA for self use vs. for sales, 2022

No.	Producer	Self-produced downstream products	Whether it produces PPA	PA for self use	PA for sales
1	Guizhou Kailin Group Co., Ltd.	Fertilizer	No	100%	0%
2	Hubei Yihua Chemical Industry Co., Ltd.	Fertilizer, phosphates	Yes	93%	7%
3	Yunnan Yuntianhua Co., Ltd.	Fertilizer, phosphates	Yes	90%	10%
4	Anhui Liuguo Chemical Co., Ltd.	Fertilizer	Yes	90%	10%
5	Hubei Xingfa Chemicals Group Co., Ltd.	Fertilizer, phosphates	Yes	90%	10%
6	Guizhou Chanhen Chemical Corporation	Fertilizer, phosphates	No	90%	10%
7	Kunming Chuan Jin Nuo Chemical Co., Ltd.	Fertilizer, phosphates	Yes	90%	10%
8	Wengfu (Group) Co., Ltd.	Fertilizer, phosphates	Yes	50%	50%
9	Sichuan Shifang Dingli Phosphate Chemical Co., Ltd.	Phosphates	No	90%	10%
10	Shifang Qishan Chemical Co., Ltd.	Phosphates	No	80%	20%
11	Chongqing Chuandong Chemical (Group) Co., Ltd.	Phosphates	No	20%	80%
12	Jiangsu Chengxing Phosph-Chemical Co., Ltd.	Phosphates, electronic chemicals	No	10%	90%
13	Hubei Sinophorus Electronic Materials Co., Ltd.	Electronic chemicals	No	5%	95%
14	Yunnan Chengjiang Dean Phosphorus Chemical Co., Ltd.	/	No	0%	100%
15	Mianyang Aostar Phosphorus Chemical Industry Co., Ltd.	/	No	0%	100%
16	Xiangyang Gaolong Phosphorus Chemical Co., Ltd.	/	No	0%	100%
17	Yunnan Jianglin Group Co., Ltd.	/	No	0%	100%
18	Guizhou Sino-Phos Chemical Co., Ltd.	/	No	0%	100%
19	Guangxi Qinzhou Capital Success Chemical Co., Ltd.	/	No	0%	100%
20	SEMIAC Electronic Chemicals Co., Ltd.	/	No	0%	100%
21	Yunphos (Taixing) Chemical Co., Ltd.	/	No	0%	100%

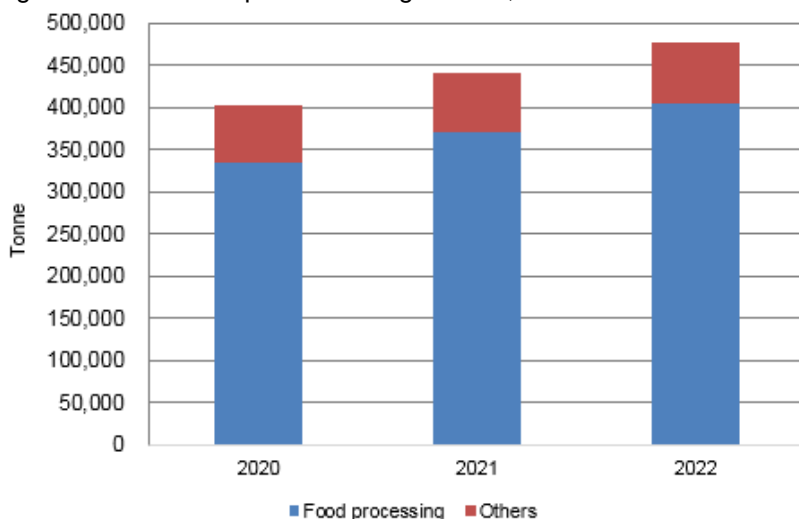
Source: CCM

4.1 Consumption of food grade PA

Food grade PA is mainly consumed in the food processing industry. With the development of the food processing industry, the demand for food grade PA and phosphates was growing, leading to the rising consumption of food grade PA over the past three years. Between 2020 and 2022, the consumption of food grade PA in China increased from 402,000 tonnes to 476,000 tonnes, with a compound annual growth rate (CAGR) of 8.8%, and the food grade PA consumed in the food processing sector as a percentage of total food grade PA consumption was 83.1%, 84.3% and 85.1%, respectively.

Food grade PA and phosphates are widely used in the food processing sector. According to the current *National Standard for Food Additive Usage* (GB 2760–2014), China approved 19 kinds of phosphoric acid and phosphate products to be used as humectants, leavening agents, acidity regulators, food stabilizers, food coagulants, anticaking agents, etc. In addition, there is increasing use of sodium triphosphate and sodium hexametaphosphate in food, suggesting that China's food grade phosphate market is still growing and is of huge growth potential.

Figure 4.1-1 Consumption of food grade PA, 2020–2022



Note: Others include feed, chemical, medicine and other fields.
Source: CCM

Applications in food processing

- As a food additive, PA can be used as an acidity regulator added to beverages and dairy products, serving as an alternative to citric acid and malic acid
- In the brewing industry as a yeast nutrient to inhibit the growth of miscellaneous bacteria, and to replace lactic acid for the adjustment of pH value during the beer saccharification
- As a flour improver
- As a blending agent for edible oil production
- In the sugar industry as a clarifier
- For the production of edible gelatin and various capsules
- Further processed into food grade phosphate

The end customers of food grade PA cover beverage, bakery, sugar, wine and oil products processors, such as the Coca-Cola Company, COFCO Corporation, Hangzhou Wahaha Group Co., Ltd.

Other applications

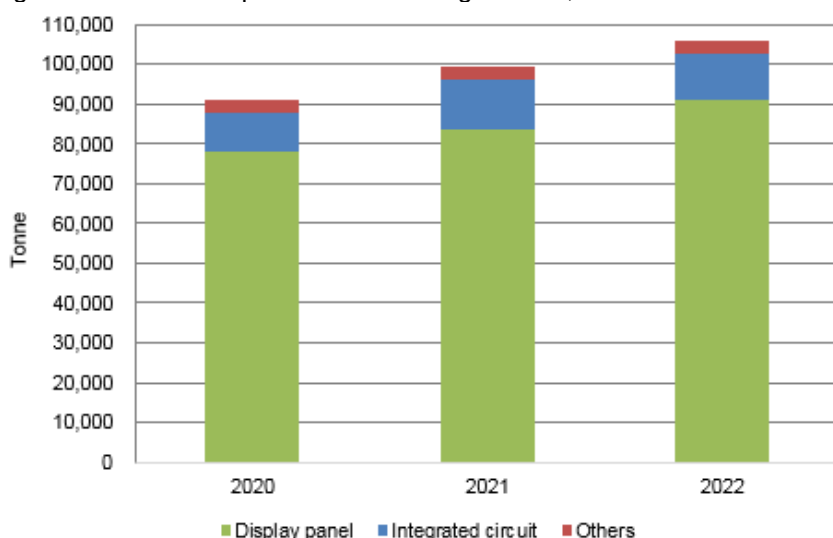
- For the production of calcium hydrogen phosphate, a feed nutrient
- In water treatment as a raw material for the production of water softener, descaling agent and phosphorus water treatment agent
- In the pharmaceutical industry, PA is used to produce sodium glycerophosphate, iron phosphate and zinc phosphate which is used as a dental cement
- Food grade purified PA can be used to produce general electronic chemicals

4.2 Consumption of electronic grade PA

As a fine phosphorus chemical product of high added value, electronic grade PA has widespread applications in integrated circuits and display panels. It is one of the main raw materials of electronic chemicals such as high-performance etching solutions, photoresist stripping solutions and cleaning solutions. From 2020 through 2022, the consumption of electronic grade PA in China rose continuously from 91,000 tonnes to 106,000 tonnes with a CAGR of 7.9%.

End customers of electronic grade PA include large-scale integrated circuit manufacturers such as Yangtze Memory Technologies Co., Ltd., Shanghai Huahong (Group) Co., Ltd. and Semiconductor Manufacturing International Corporation, as well as electronic chemical manufacturers such as Shanghai Sanfuming Electronic Materials Co., Ltd., Jiangyin Jianghua Micro-electronic Materials Co., Ltd. and Jiangyin Runma

Figure 4.2-1 Consumption of electronic grade PA, 2020–2022



Note: Other applications mainly include the production of high purity phosphate and glass fiber.
Source: CCM

- Display panel

Electronic grade PA with low purity is mainly used for the cleaning of components of liquid crystal panels. With the growth of flat-panel display technology and the changes in the global economic situation and the electronic product market, China's display panel industry has witnessed rapid progress in recent years and has gradually become one of the global display panel centers. According to the China Center for Information Industry Development, China's new display industry enjoyed sustained growth between 2012 and 2021, with a CAGR of 25.8%.

In 2022, 91,200 tonnes of electronic grade PA was consumed by the display panel industry, accounting for 86% of the total consumption of electronic grade PA. It is expected that the growing display panel industry will further fuel the robust development of the electronic grade PA market.

- Integrated circuit (IC)

The electronic grade PA with high purity is mainly used for cleaning and etching in the manufacturing of integrated circuits. Among others, E2 electronic grade PA has the highest purity, which is used in the etching process of the manufacturing of 8-inch and 12-inch wafers.

The IC industry is one of the pillar industries in the national economy. The development of the Internet of Things, smart manufacturing, new energy and information security industries and 5G is expected to continuously spur the demand for integrated circuits. According to the National Bureau of Statistics, China's production of integrated circuits was 261.3 million units in 2020 and 359.4 million units in 2021, up 16.2% and 37.6% YoY, respectively. But the figure dropped by 9.8% to 324.2 million units in 2022, a result of sluggish demand as the global semiconductor market was weak. Therefore, the consumption of electronic grade PA in the IC industry shrank by 8.1% to 11,300 tonnes.

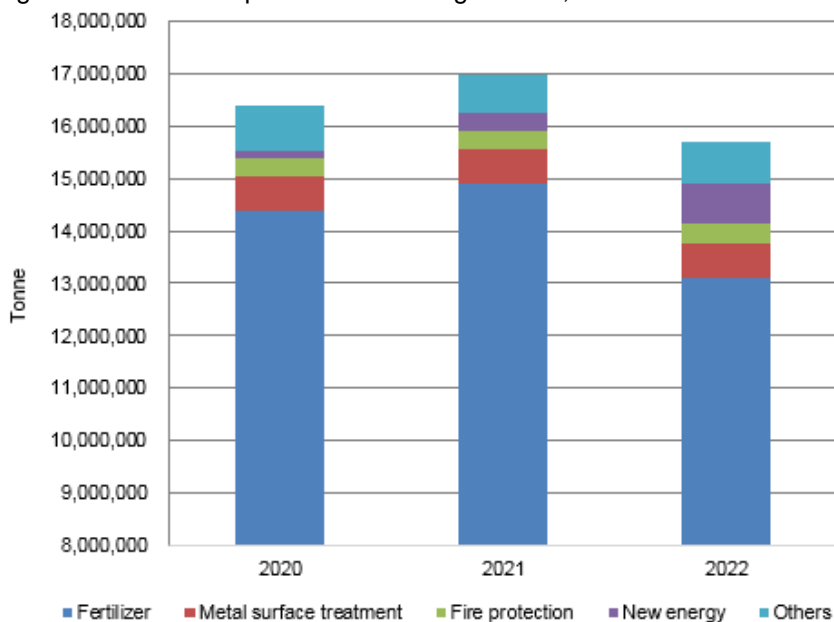
- Other fields

A few electronic grade PA is used in the production of high-purity phosphate, glass fiber, etc. In 2022, about 3.4% of the electronic grade PA was consumed in other fields.

4.3 Consumption of industrial grade PA

Industrial grade PA is widely used in fertilizer production, metal surface treatment, fire protection, new energy and other fields. China's consumption of industrial grade PA in 2020–2022 was 16.4 million tonnes, 17.0 million tonnes, and 15.7 million tonnes, respectively. The change in the consumption is primarily linked to the production volume of phosphate fertilizer.

Figure 4.3-1 Consumption of industrial grade PA, 2020–2022



Note: Other fields mainly refer to feed, chemical, metallurgy and medicine.
Source: CCM

- Phosphate fertilizer

China's production volume of phosphate fertilizer showed an overall rise-and-fall trajectory from 2020 to 2022. In 2021, the increased grain production and export demand boosted the production of phosphate fertilizer to 16.8 million tonnes, up from the 15.9 million tonnes in 2020. But in 2022, the figure fell to 15.2 million tonnes, primarily explained by the sharp decline in phosphate fertilizer export as China rolled out new inspection policies for fertilizer export in Oct. 2021. Therefore, PA consumption dropped sharply in 2022.

- Metal surface treatment

One of the traditional applications of industrial grade PA is in metal surface treatment. PA reacts with active agents like dihydrogen phosphate containing manganese, iron and zinc, generating phosphate coatings to prevent metal from further corrosion. The PA used in metal surface treatment grew steadily from 650,000 tonnes in 2020 to 670,000 tonnes in 2022.

Industrial grade PA for this application is generally sold in small quantities, yet there is great demand for it. The end customers are electroplating material manufacturers such as Zhuhai Changxian New Materials Technology Co., Ltd., Hangzhou Hualian Metal Chemical Co., Ltd. and Wenzhou Ouyun New Material Co., Ltd.

- New energy

With the gradual expansion of China's new energy vehicle market, lithium iron phosphate (LFP) has become one of the important downstream applications of the phosphorus chemical industry in China. The increased shipments of LFP power batteries and LFP storage batteries drove up the rapid growth of LFP production. In 2020–2022, China produces approximately 164,000 tonnes, 474,000 tonnes and 1.03 million tonnes of LFP, respectively.

Besides, technological progress also has implications for the exponential growth of LFP production. Carmakers are switching to LFP batteries from ternary lithium batteries due to the improving performance of LFP batteries in low-temperature conditions, high safety and cost-effectiveness. In the long run, the driving force of the growth of the phosphorus chemical industry is expected to move from the traditional agrochemical to new energy, which will continuously prompt the market demand for wet process purified PA.

The new energy sector consumed up to 760,000 tonnes of PA in 2022. That accounted for 24.0% of the non-phosphate fertilizer consumption, significantly higher than the share of 4.9% in 2020.

In the new energy sector, industrial grade PA is mainly used in the production of LFP and its precursor iron phosphate. End customers including manufacturers of lithium battery materials or intermediate products such as Tongling Nayuan Material Technology Co., Ltd., Jiangsu GCL Lithium Battery Technology Co., Ltd. and Nexttech Materials Co., Ltd. purchase PA to produce LFP or iron phosphate. Some PA producers also produce iron phosphate.

- Fire protection

For firefighting, industrial grade PA is mostly used to produce monoammonium phosphate (MAP), the raw material of dry powder extinguishing agent. The *National Standard for Powder Extinguishing Agent* (GB 4066–2017), which came into effect in July 2018, raised the requirement for the minimum content of main components in powder extinguishing agents from 50% to 75%. With the new national standard in place, the market demand for fire protection-use MAP has maintained steady growth. The consumption of PA for fire protection climbed up from 350,000 tonnes in 2020 to 360,000 tonnes in 2022.

Most fire protection-use MAP is produced by manufacturers of phosphorus products such as Guizhou Chanhen Chemical Corporation, Hubei Yihua Chemical Industry Co., Ltd., Kingenta Norsterra Chemical Co., Ltd. and Sinochem Chongqing Fuling Chemicals Co., Ltd.

- Other fields

The above consumption fields aside, industrial grade PA can also be used in feed, chemical, metallurgy, medicine and other fields in the form of phosphates such as calcium phosphate, sodium phosphate and potassium phosphate, and phosphorus-containing drugs. The consumption of PA for other purposes in 2020–2022 was 880,000 tonnes, 735,000 tonnes and 810,000 tonnes, respectively.

5 Forecast on PA industry in China, 2023–2025

5.1 Forecast of food grade PA and industrial grade PA

- Phosphate ore market

In China, the phosphate ore mining and beneficiation industry features three highs—high industry concentration, high vertical integration, and high barrier to entry. Meanwhile, market demand for ferric phosphate (FePO_4) has been driven up by the booming market of new energy battery, tightening the supply-demand gap therein. The cost of mining and beneficiation, from a long-term prospective, will be pushed up by the growing ore scarcity and lower grade, and the price of phosphate ore will move to a higher level in the country. Share of phosphate ore in component costs of downstream products is rising, implying more capacities of phosphorus fertilizers and phosphorus chemicals would be converged to or established by the integrated businesses that own ore resources.

On supply, as some provincial and regional governments are implementing limits on interprovincial transport of phosphate ore, market supply has been at low level. Most of currently planning phosphate ore capacity construction projects are designed for company's internal use in producing downstream products.

- PA production

The combined capacity of industrial grade and food grade PA is estimated to ramp up to 23.7 million t/a, 24.9 million t/a and 25.8 million t/a in 2023–2025. Although China's PA industry is still facing overcapacity, the currently planning PA capacity aims to achieve the transformation and upgrading of the industry, reaching to downstream products of higher added value to extend the industry chain.

Replacement of thermal process with wet process is on the rise in the production of PA. PA and yellow phosphorus are enriched with element phosphorus. However, the production of yellow phosphorus consumes a great amount of energy which explains the higher cost of the PA production from yellow phosphorus than the wet process and purification. Increasing amount of phosphorus chemical companies is planning to build up their purified PA capacity supported by improved technological maturity. But one tonne of PA amasses five tonnes of phosphogypsum which means treatment of phosphogypsum will become a key matter to be addressed in expanding capacity for phosphorus chemicals. Producers with mature phosphogypsum treatment installation will enjoy a greater advantage in this regard.

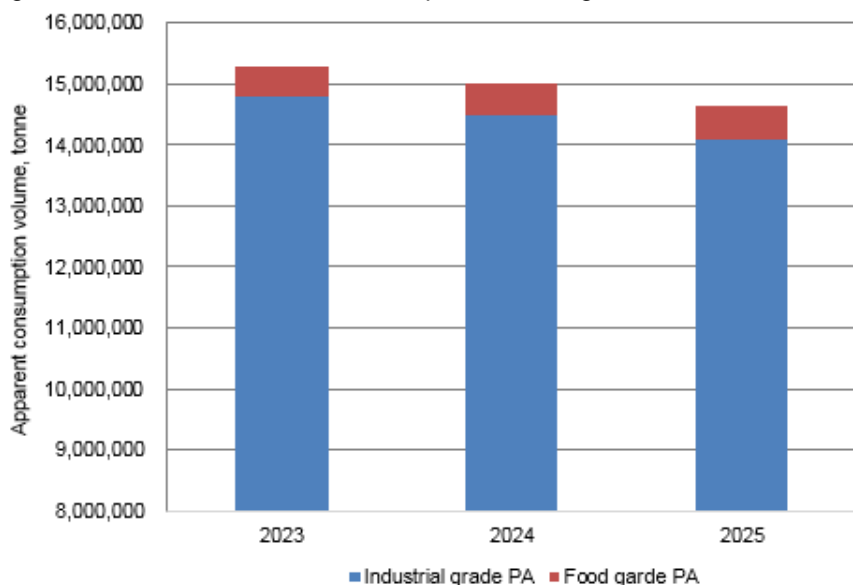
- Demand/consumption

China's market demand for phosphate fertilizers has remained intact. But the country's continued efforts to phase out backward phosphate fertilizer capacity in stages, and any alterations in the national planting structure and fertilization practices may bring down the overall domestic demand. The overall consumption of PA in China is projected to shrink from 2023 to 2025.

It is worth noting that the newly added capacity for new energy materials could spark a hike in demand for phosphate ore and PA. Lithium iron phosphate (LFP) is an important cathode material of lithium battery. In 2022, China announced it would no longer subsidize new energy vehicles, sending automobile manufacturing cost up, but since then lower-cost LFP battery has overtaken ternary lithium battery to become the best selling battery type by volume. On the momentum of lithium ion battery, the new energy vehicle and energy storage industries emerge rapidly, concurrently accelerating the LFP industry development since 2020: according to incomplete statistics, China has planned to install 4.66 million t/a new LFP capacity since 2022, along with 7.03 million t/a for ferric phosphate. Commercialization of LFP is playing out in a larger scale. While there are many production routes for LFP, use of cost-efficient and performing ferric phosphate is expected to become a mainstay. It is estimated that market in future will see rises in ferric phosphate demand and in the number of new capacity construction of ferric phosphate and phosphoric acid as a supporting part. Market demand for ferric phosphate is expected to reach 2.25 million tonnes by 2025.

According to the current *National Standard for Food Additive Usage* (GB 2760–2014), there are 19 kinds of phosphoric acid and phosphates allowed to be used as food additives in China, while the US and Japan have approved 31 and 26 kinds, respectively, indicating that food-grade PA and phosphates in China still have certain potential moving forward. Expectation for 2023 food grade PA market is that production will face depression of overseas market but stable demand of the domestic one. For a longer term, the diversity of Chinese food grade phosphate products will improve as the industry grows in scale; and food grade PA production and demand will continue to rise at a steady pace, potentially boosted by the premiumisation of the end-use industries.

Figure 5.1-1 Forecast on the consumption of food grade PA and industrial grade PA in China, 2023–2025



Source: CCM

5.2 Forecast of electronic grade PA

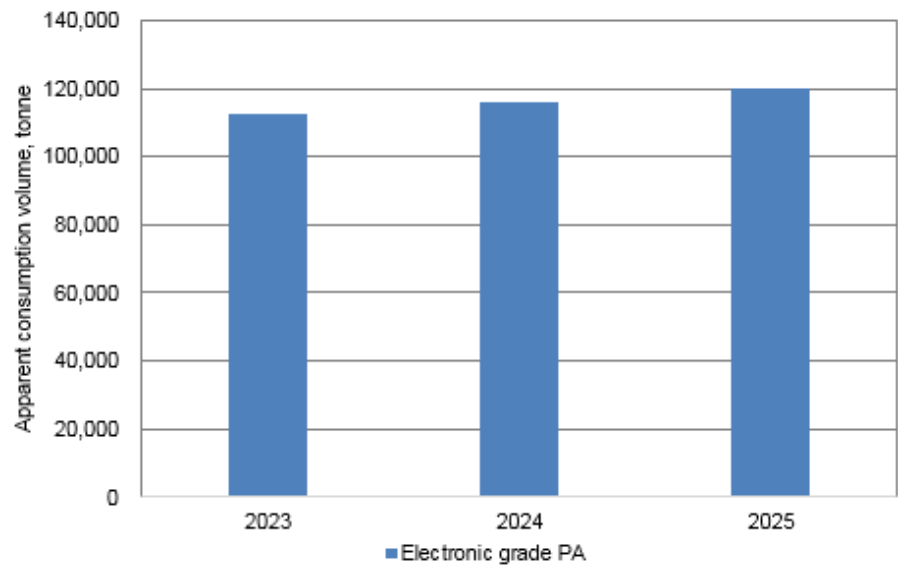
China's electronic grade PA capacity is estimated to reach 277,000 t/a in 2023 and stabilize at 308,000 t/a in 2024 and 2025, with consumption at a steady three-year compound annual growth rate of 3.3%, rising from 112,300 tonnes in 2023 to 119,800 tonnes in 2025.

Novel display, as one of the downstream application fields of electronic grade PA, is one of the fastest growing sectors in China in recent years, partially prompted by the country's endeavors to expand domestic demand to the level that has seldom been seen in other countries and has helped grow traditional applications such as smart phone, television and displayer. In 2022, China's display industry absorbed increased amount of foreign investment facilitating the industry growth. Apart from the improvement in market scaling, the industrial investment structure has seen positive changes: investment amount in materials surpassed that in devices for the first time, shifting largely from LCD to OLED, Micro LED and other upper-stream products. That has helped boost the consumption of electronic grade PA.

In integrated circuit (IC) area, China's policies to develop the national semiconductor industry have been carried out firmly: its 14th Five-year Development Plan (2021–2025) underscores structured development of the IC industry, and innovation and industrialization of semiconductor and other emerging fronts. In H1 2023, overseas sales eased and domestic recovery slowed down. But even though the overall downstream demand has remained sluggish, expectation is that world economy will pick up gradually, and with government supports, the PA industry will be given more opportunities to boom.

Looking forward to the next three years, the development of China's electronic information manufacturing industry is expected to show a restorative growth trend, with the electronic grade PA market growing correspondingly and steadily.

Figure 5.2-1 Forecast on consumption of electronic grade PA in China, 2023–2025



Source: CCM

6 Company profiles of key producers

6.1 Yunnan Yuntianhua Co., Ltd.

- Basic information

Address: No. 1417, Dianchi Road, Kunming City, Yunnan Province

Tel: +86-0871-64327177

E-mail: zqb@yth.cn

Website: www.yyth.com.cn

Yunnan Yuntianhua Co., Ltd. (Yuntianhua, stock code: 600096.SH) was founded by Yuntianhua Group Co., Ltd. (Yuntianhua Group) and listed on the Shanghai Stock Exchange in 1997. Yuntianhua Group's main business includes phosphatic fertilizers, glass fiber and chemical raw materials. The group claims one of the top three glass fiber producers, the second largest phosphatic fertilizer producer, and the biggest polyformaldehyde producer in China. As of March 2022, Yuntianhua Group has a total of 10.02 million t/a fertilizer production capacity, composed of 5.55 million t/a basic phosphatic fertilizer, 2 million t/a nitrogen fertilizer, and 2.47 million t/a compound (mixed) fertilizer. Yuntianhua Group is also the biggest phosphate mining and beneficiation operator in China. Its raw ore

production capacity

has reached 14.5 million t/a, and processing capacities of ore washing and flotation to 6.18 million t/a and 7.5 million t/a. In addition, as of 2021, it has 30,000 t/a yellow phosphorus, 140,000 t/a sodium tripolyphosphate and 500,000 t/a calcium hydrogen phosphate production capacities.

Table 6.1-1 Financials of Yuntianhua, 2021–2022, RMB

Year	Total sales	Total operating cost	Gross profit	Year-end total assets
2021	63,249,227,894	54,598,667,517	8,650,560,377	53,142,209,878
2022	75,313,292,458	63,099,829,443	12,213,463,014	53,222,799,570

Source: Yuntianhua

Table 6.1-2 PA related subsidiaries of Yuntianhua, as of July 2023

No.	Subsidiary	Ownership percentage
1	Yunnan Puning Yellow Phosphorus Co., Ltd.	100.00%
2	Yunnan Tian'an Chemical Co., Ltd.	100.00%
3	Yunnan Phosphate Group Co., Ltd.	81.40%
4	Yunnan Sanhuan Zhonghua Chemical Fertilizer Co., Ltd.	60.00%
5	Yunnan Phosphate Group Haikou Phosphorus Industry Co., Ltd.	50.00%

Source: CCM

Table 6.1-3 PA capacity and output of Yuntianhua, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	2,270,000	2,270,000	2,270,000
Output of industrial grade PA, tonne	1,940,000	1,950,000	1,925,000
Output of food grade PA, tonne	60,000	70,000	75,000

Source: CCM

Table 6.1-4 Government-subsidized projects of Yuntianhua, 2020–2022

Year	Project	Subsidy, RMB
2022	Research and Development Project of Key Technologies for Manufacturing Highly Value-added Materials from Large-scale Phosphogypsum Calcination	4,427,500
2022	900,000 t/a Phosphogypsum Comprehensive Utilization Demonstration Project (Phase I) in Anning (a county-level city under Kunming)	3,750,000
2022	Research and Development Project of Key Technologies for Resource Utilization of Phosphorus Ore Flotation Tailings	3,000,000
2022	Phosphate Concentration Low-pressure Steam Power Generation Project	2,500,000
2022	Development and Transformation Project of Industrialization Technologies for Efficient Production of High-quality and Green Feed Grade Calcium Phosphate from Barren, Low-grade Phosphate Ore	2,000,000
2022	Battery Grade Monoammonium Phosphate (MAP) Project	1,900,000
2022	Research and Development Project for Clean Utilization of Phosphorus Resources and Near-zero Discharge of Heavy Solid Wastes at Source	246,000
2021	Research and Development Project for Clean Utilization of Phosphorus Resources and Near-zero Discharge of Heavy Solid Wastes at Source	1,167,000
2020	Collophanite Flotation Tailings Emission Reduction and Resource Recycling Project	1,500,000
2020	Research and Development Project for Clean Utilization of Phosphorus Resources and Near-zero Discharge of Heavy Solid Wastes at Source	820,900

Source: CCM

6.2 Wengfu (Group) Co., Ltd.

- Basic information

Address: No. 57, Shinan Road, Nanming District, Guiyang City, Guizhou Province

Tel: +86-0851-85513311

E-mail: wfdongban@163.com

Website: www.wengfu.com

Founded in 2008, Wengfu (Group) Co., Ltd. (Wengfu Group) has over 50 subsidiaries and five main production R&D bases located in Guizhou, Gansu, Sichuan and Fujian provinces. Currently, Wengfu Group has 7,500,000 t/a phosphate mining capacity, 3,120,000 t/a phosphate fertilizer production capacity, 2,730,000 t/a chemicals production capacity, etc.

Details of the group's five production bases are as follows:

- Fuquan City, Guizhou: As Wengfu Group's core base for production and R&D, the Fuquan base was completed and put into use in 1999, covering an area of approximately 3,000 mu.

- Weng'an County, Guizhou: The Weng'an base has a phosphate mining capacity of 3.5 million t/a, and a yellow phosphorus production capacity of 50,000 t/a which was completed in construction in 2016.

- Shanghang County, Fujian: The Shanghang base (Wengfu Zijin Chemical Co., Ltd., established in May 2010) was jointly funded by Wengfu Group, Zijin Copper Co., Ltd. and the Japan-based National Federation of Agricultural Cooperative Associations (or ZEN-NOH Group). It has formed production capacities of 400,000 t/a for compound phosphate fertilizers, 300,000 t/a for wet process purified phosphoric acid, 10,000 t/a for ammonium phosphate, 20,000 t/a for food grade potassium phosphate, etc.

- Dazhou City, Sichuan: Invested with more than RMB6 billion, the Dazhou base produces sulfur-based sulfuric acids, phosphoric acids, wet purified phosphoric acids, diammonium phosphate, and phosphates of industrial grade, food grade and battery grade.

- Jinchang City, Gansu: The Jinchang base (Gansu Wengfu Chemical Co., Ltd., established in October 2006), has formed mineral processing capacity of 1.6 million t/a and production capacities of 370,000 t/a for phosphoric acids, 600,000 t/a for ammonium phosphate, 100,000 t/a for compound fertilizers, etc.

Table 6.2-1 Financials of Wengfu Group, 2021–2022, RMB

Year	Total sales	Total operating cost	Gross profit	Year-end total assets
2021	3,037,367	2,687,355	350,012	3,911,182
2022	3,686,634	3,125,082	561,552	3,673,156

Source: Wengfu Group

Table 6.2-2 PA related subsidiaries of Wengfu Group, as of July 2023

No.	Subsidiary	Ownership percentage
1	Guizhou Wengfu Chemical Co., Ltd.	100.00%
2	Weng'an Daxin Beidoushan Phosphate Mine Co., Ltd.	100.00%
3	Wengfu Dazhou Chemical Co., Ltd.	91.24%
4	Gansu Wengfu Chemical Co., Ltd.	70.00%
5	Wengfu Zijin Chemical Co., Ltd.	51.02%
6	Guizhou Wengfu Lantian Fluorine Chemical Co., Ltd.	51.00%
7	Yunnan Wengfu Yuntianhua Fluorine Chemical Technology Co., Ltd.	/

Note: 1. Guizhou Wengfu Lantian Fluorine Chemical Co., Ltd. holds 51% equity of Yunnan Wengfu Yuntianhua Fluorine Chemical Technology Co., Ltd.;

2. Weng'an Daxin Beidoushan Phosphate Mine Co., Ltd., Yunnan Wengfu Yuntianhua Fluorine Chemical Technology Co., Ltd., Guizhou Wengfu Lantian Fluorine Chemical Co., Ltd. jointly established Guizhou Wengfu Kailin Fluorosilicone New Material Co., Ltd.
Source: CCM

Table 6.2-3 PA Capacity and output of Wengfu Group, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	1,870,000	1,870,000	1,870,000
Output of industrial grade PA, tonne	1,280,000	1,330,000	1,160,000
Output of food grade PA, tonne	320,000	330,000	427,000

Source: CCM

6.3 Hubei Xingfa Chemicals Group Co., Ltd.

- Basic information

Address: No. 58, Gaoyang Avenue, Gufu Town, Xingshan County, Yichang City, Hubei Province

Tel: +86-0717-6760850

E-mail: dmb@xingfagroup.com

Website: www.xingfagroup.com

Hubei Xingfa Chemical Group Co., Ltd. (Hubei Xingfa, stock code: 600141.SH) was founded in 1994 and listed on the Shanghai Stock Exchange in 1999. Hubei Xingfa is one of the largest producers in the phosphates specialty industry in China. It manufactures 591 products covering 15 categories with applications of industrial grade, feed grade, food grade, dental-care grade, pharmaceutical grade, electronic grade. Hubei Xingfa, focusing on fine chemicals, has built production bases in Yichang Xingfa Fine Chemical Industrial Park, Yidu Xingfa Eco-Industrial Park and Xiangyang Xingfa Circular Economy Industrial Park in Hubei Province, and others in Henan, Guizhou, Xinjiang Uygur Autonomous Region, Inner Mongolia Autonomous Region, Jiangsu, etc. Currently, Hubei Xingfa has 5.85 million t/a phosphate mining production capacity, and 200,000 t/a capacity for fine phosphate, 1 million t/a for ammonium phosphate, etc.

Table 6.3-1 Financials of Hubei Xingfa, 2021–2022, RMB

Year	Total sales	Total operating cost	Gross profit	Year-end total assets
2021	23,902,090,235	18,173,896,267	5,728,193,968	36,735,153,694
2022	30,310,653,688	22,142,397,470	8,168,256,218	41,612,495,313

Source: Hubei Xingfa

Table 6.3-2 PA related subsidiaries of Hubei Xingfa, as of July 2023

No.	Subsidiary	Ownership percentage
1	Baokang Chufeng Chemical Co., Ltd.	100.00%
2	Hubei Trison Chemicals Co., Ltd.	100.00%
3	Inner Mongolia Xingfa Technology Co., Ltd.	100.00%
4	Weng'an County Longma Phosphorus Industry Co., Ltd.	100.00%
5	Xiangyang Xingfa Chemical Co., Ltd.	100.00%
6	Yidu Xingfa Chemical Co., Ltd.	100.00%
7	Hubei Sinophorus Electronic Materials Co., Ltd.	55.29%
8	Hubei Jixing Chemical Group Co., Ltd.	55.00%

Source: CCM

Table 6.3-3 PA Capacity and output of Hubei Xingfa, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	460,000	860,000	860,000
Output of industrial grade PA, tonne	337,000	376,000	361,000
Output of food grade PA, tonne	51,700	63,600	62,600
Output of electronic grade PA, tonne	16,400	19,500	22,700

Note: Output of food grade PA includes the output of food grade PA of Hubei Sinophorus Electronic Materials Co., Ltd.

Source: CCM

Table 6.3-4 Government-subsidized projects of Hubei Xingfa, 2020–2022

Year	Project	Subsidy, RMB
2022	3,000,000 t/a Low-Grade Collophanite Beneficiation and Deep Processing Project	10,000,000
2022	30,000 t/a Electronic Grade Phosphoric Acid Technological Transformation Project	1,700,000
2021	60,000 t/a Ultra-High-Purity Electronic Grade Chemicals for Chips Project	38,000,000
2021	Yellow Phosphorus Clean Production Technological Transformation Project	19,200,000
2021	30,000 t/a Electronic Grade Phosphoric Acid Technological Transformation Project	10,000,000
2021	Project of Phosphorus, Sulphur and Chlorine Solid Wastes Reduction at Source and Resource Recycling Technology in Fine Chemical Park Area	4,567,300
2020	Project of Phosphorus, Sulphur and Chlorine Solid Wastes Reduction at Source and Resource Recycling Technology in Fine Chemical Park Area	3,377,700
2020	100,000 t/a Wet Process Phosphoric Acid Refining Technological Transformation Project	1,600,000

Source: CCM

6.4 Anhui Liuguo Chemical Co., Ltd.

- Basic information

Address: Tonggang Road, Tongling City, Anhui Province

Tel: +86-0562-2170506

E-mail: liuguo@liuguo.com

Website: www.liuguo.com

Anhui Liuguo Chemical Co., Ltd. (Anhui Liuguo, stock code: 600470.SH) was established in 2000 and listed on the Shanghai Stock Exchange in 2004. The company is mainly engaged in the production, processing and sale of fertilizers, chemicals, chemical raw materials, fine phosphates, hydrogen peroxide, phosphogypsum products. It has nine holding subsidiaries and has three phosphoric acid production lines (wet process), equipped with the 4th generation of Prayon equipment and other processes, as well as multiple sets of production lines for DAP (diammonium phosphate), MAP (monoammonium phosphate), and NPK (nitrogen, phosphorus and potassium compound fertilizers).

Table 6.4-1 Financials of Anhui Liuguo, 2021–2022, RMB

Year	Total sales	Total operating cost	Gross profit	Year-end total assets
2021	5,984,502,357	5,730,889,819	253,612,538	5,370,261,852
2022	7,549,219,616	7,309,239,396	239,980,220	6,995,025,088

Source: Anhui Liuguo

Table 6.4-2 PA related subsidiaries of Anhui Liuguo, as of July 2023

No.	Subsidiary	Ownership percentage
1	Hubei Huiyang New Materials Co., Ltd.	100.00%
2	Tongling Guoxing Chemical Co., Ltd.	70.00%
3	Anhui Zhongyuan Chemical Fertilizer Co., Ltd.	60.00%
4	Tongling Sinco Fine Chemical Co., Ltd.	60.00%
5	Hubei Liuguo Chemical Co., Ltd.	51.00%

Source: CCM

Table 6.4-3 PA Capacity and output of Anhui Liuguo, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	650,000	650,000	650,000
Output of industrial grade PA, tonne	450,000	460,000	470,000

Source: CCM

Table 6.4-4 Government-subsidized projects of Anhui Liuguo, 2020–2022

Year	Project	Subsidy, RMB
2021	Green Development Project of the Yangtze River Economic Belt (for Comprehensive Improvement of Phosphogypsum-Impacted Ecological Environment, Phosphogypsum Backfilling, and Phosphogypsum Ecological Governance and Restoration)	42,370,000
2020	Green Development Project of the Yangtze River Economic Belt (for Comprehensive Improvement of Phosphogypsum-Impacted Ecological Environment, Phosphogypsum Backfilling, and Phosphogypsum Ecological Governance and Restoration)	50,000,000
2020	Industrial Upgrading project	3,000,000

Source: CCM

6.5 Guizhou Kailin Group Co., Ltd.

- Basic information

Address: 23 Jinqi Road, Jinzhong Town, Kaiyang County, Guiyang City, Guizhou Province

Tel: +86-0851-87714220

E-mail: 332435238@qq.com

Website: N/A

Guizhou Kailin Group Co., Ltd. (Guizhou Kailin, formerly known as Guizhou Kaiyang Phosphorus Mine) was established in October 1958 and is wholly-owned by Guizhou Phosphate Chemical Group. Currently, Guizhou Kailin has a phosphate mining capacity of 8 million t/a and production capacities of 2.07 million t/a for high-concentration phosphate compound fertilizers (1.24 million t/a DAP, 320,000 t/a MAP, 300,000 t/a TSP (triple superphosphate), 80,000 t/a SSP (single superphosphate), 130,000 t/a industrial grade ammonium dihydrogen phosphate, etc.), 25,000 t/a and 50 t/a respectively for sodium silicofluoride and iodine (by products); and it is capable of producing 2 million t/a of sulfuric acid and 600,000 t/a of PA.

Table 6.5-1 PA related subsidiaries of Guizhou Kailin, as of July 2023

No.	Subsidiary	Ownership percentage
1	Guizhou Kailin Fertilizer Co., Ltd.	100.00%
2	Guizhou Kailin Fine Phosphorus Chemical Co., Ltd.	100.00%
3	Guizhou Kailin Power Supply Co., Ltd.	100.00%
4	Guizhou Kailin Xifeng Synthesis Ammonia Co., Ltd.	100.00%
5	Guizhou Kaiyang Chemical Co., Ltd.	100.00%
6	Guizhou Wengfu Kailin Fluorosilicone New Material Co., Ltd.	49.00%

Source: CCM

Table 6.5-2 PA Capacity and output of Guizhou Kailin, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	600,000	600,000	600,000
Output of industrial grade PA, tonne	500,000	550,000	550,000

Source: CCM

6.6 Hubei Yihua Chemical Industry Co., Ltd.

- Basic information

Address: No. 52 Yanjiang Avenue, Xiling District, Yichang City, Hubei Province

Tel: +86-010-63704082

E-mail: mailliyuhan@163.com

Website: www.hbyihua.cn

Hubei Yihua Chemical Co., Ltd. (Hubei Yihua, stock code: 000422.SZ), a subsidiary of Hubei Yihua Group Co., Ltd. (Yihua Group), was established in 1992 and listed on the Shenzhen Stock Exchange in 1996. Hubei Yihua mainly manufactures raw materials and products in the coal chemical industry, chlor alkali chemical industry, phosphorus-fluorine chemical industry and fine chemical industry. The company has established over 20 R&D centers and production bases in Hubei, Inner Mongolia Autonomous Region, Qinghai, Xinjiang Uygur Autonomous Region, and other provinces. Currently, it has urea production capacity of 1.56 million t/a and production capacities of 1.26 million t/a for DMP, 840,000 t/a for PVC (polyvinyl chloride), and about 60,000 t/a for pentaerythritol.

Table 6.6-1 Financials of Hubei Yihua, 2021–2022, RMB

Year	Total sales	Total operating cost	Gross profit	Year-end total assets
2021	18,544,062,134	15,807,170,875	2,736,891,259	20,866,134,859
2022	20,712,522,439	18,414,981,610	2,297,540,829	19,666,579,121

Source: Hubei Yihua

Table 6.6-2 PA related subsidiaries of Hubei Yihua, as of July 2023

No.	Subsidiary	Ownership percentage
1	Hubei Yihua Fertilizer Industry Co., Ltd.	67.57%
2	Hubei Yihua Songzi Fertilizer Industry Co., Ltd.	51.00%

Source: CCM

Table 6.6-3 PA Capacity and output of Hubei Yihua, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	600,000	600,000	600,000
Output of industrial grade PA, tonne	400,000	400,000	400,000

Source: CCM

Table 6.6-4 Government-subsidized projects of Hubei Yihua, 2020–2022

Year	Project	Subsidy, RMB
2022	Project of Phosphogypsum Slag Yard Safety Upgrade, Technological Transformation and Comprehensive Governance	3,000,000
2021	Phosphogypsum Warehouse Comprehensive Governance Project	5,582,000
2020	Phosphogypsum Warehouse Comprehensive Governance Project	7,000,000
2020	Technology Development Project of High-magnesium, Medium- and Low-grade Phosphate Ore Column Flotation Process	1,000,000

Source: CCM

6.7 Jiangsu Chengxing Phosph-Chemicals Co., Ltd.

- Basic information

Address: No. 618, Meiyuan Street, Jiangyin City, Jiangsu Province

Tel: +86-0510-80622327

E-mail: cx@phosphatechina.com

Website: www.chengxingphoschem.com

Jiangsu Chengxing Phosph-Chemicals Co., Ltd. (Jiangsu Chengxing, stock code: 600078.SH), listed on the Shanghai Stock Exchange in 1997, has 20 subsidiaries located in Jiangsu, Guangxi, Yunnan and other provinces, with two deep processing bases of fine phosphorus chemicals in Jiangyin City, Jiangsu Province and Qinzhou City, Guangxi Province, and two large-scale production bases of yellow phosphorus raw materials in Xuanwei City and Mile City, Yunnan Province respectively. Currently, Jiangsu Chengxing has PA production capacities of 600,000 t/a for thermal process PA, 95,000 t/a for phosphate, and about 160,000 t/a for yellow phosphorus supported with self-produced phosphate ore.

Table 6.7-1 Financials of Jiangsu Chengxing, 2021–2022, RMB

Year	Total sales	Total operating cost	Gross profit	Year-end total assets
2021	3,333,405,365	2,997,979,997	335,425,368	7,410,554,635
2022	4,537,553,209	3,885,607,703	651,945,506	5,637,116,355

Source: Jiangsu Chengxing

Table 6.7-2 PA related subsidiaries of Jiangsu Chengxing, as of July 2023

No.	Subsidiary	Ownership percentage
1	Guangxi Qinzhou Chengxing Chemical Technology Co., Ltd.	100.00%
2	Jiangyin Chengxing Daily Chemical Co., Ltd.	100.00%
3	Yunnan Xuanwei Phosphorus Electricity Co., Ltd.	100.00%
4	Yunnan Mile Phosphorus Electricity Co., Ltd.	55.00%

Source: CCM

Table 6.7-3 PA Capacity and output of Jiangsu Chengxing, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	720,000	600,000	600,000
Output of industrial grade PA, tonne	177,000	94,000	108,000
Output of food grade PA, tonne	157,000	95,000	138,000
Output of electronic grade PA, tonne	42,000	41,000	43,000

Source: CCM

Table 6.7-4 Government-subsidized projects of Jiangsu Chengxing, 2020–2022

Year	Project	Subsidy, RMB
2022	35,000 t/a Calcium Phosphate Production Line Construction Project	2,000,000
2021	35,000 t/a Calcium Phosphate Production Line Construction Project	1,000,000
2020	Electronic Grade Phosphoric Acid Technological Transformation Project	105,417

Source: CCM

6.8 Kunming Chuan Jin Nuo Chemical Co., Ltd.

- Basic information

Address: Sifangdi Industrial Park, Tongdu Town, Dongchuan District, Kunming City, Yunnan province

Tel: +86- 0871-62124601

E-mail: cjnzqb@163.com

Website: www.cjnphos.com

Kunming Chuan Jin Nuo Chemical Co., Ltd. (Kunming Chuan Jin Nuo, stock code: 300505.SZ) was founded in June 2005 and went public on the Shenzhen Stock Exchange in 2016.

Kunming Chuan Jin Nuo has four operation bases:

- Kunming Manufacturing Base is invested with RMB1.5 billion, mainly producing feed grade phosphates (500,000 t/a) and fertilizer grade phosphates (300,000 t/a), and such related products as sodium fluorosilicate and refined iron ore powder (200,000 t/a in total).
- Guangxi Manufacturing Base is invested with RMB2.4 billion, mainly producing fine phosphates of industrial grade, food grade, electronic grade, etc. (400,000t/a), and such related products as basic phosphate fertilizers, sodium fluorosilicate, phosphogypsum building materials (1 million t/a in total).
- New Energy Material Manufacturing Base has remained a project in progress as of the reporting date, having completed the construction of iron phosphate production capacity. The project is designed to form an integrated industrial chain from iron phosphate to lithium iron phosphate and install 150,000 t/a iron phosphate and 100,000 t/a lithium iron phosphate production capacities with an investment of RMB2.5 billion.
- Technological Innovation Base includes one R&D center of traditional phosphorus chemicals and one of

new energy materials, built to foster the company's sustainable development.

Table 6.8-1 Financials of Kunming Chuan Jin Nuo, 2021–2022, RMB

Year	Total sales	Total operating cost	Gross profit	Year-end total assets
2021	1,535,877,611	1,316,699,038	219,178,573	2,345,253,988
2022	2,519,844,095	2,117,349,427	402,494,668	3,056,657,275

Source: Kunming Chuan Jin Nuo

Table 6.8-2 PA related subsidiaries of Kunming Chuan Jin Nuo, as of July 2023

No.	Subsidiary	Ownership percentage
1	Guangxi Chuan Jin Nuo New Energy Co., Ltd.	100.00%
2	Yunnan Qinglin Phosphate Fertilizer Co., Ltd.	100.00%
3	Guangxi Chuan Jin Nuo Chemical Co., Ltd.	90.91%

Source: CCM

Table 6.8-3 PA Capacity and output of Kunming Chuan Jin Nuo, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	190,000	390,000	390,000
Output of industrial grade PA, tonne	150,000	140,000	140,000
Output of food grade PA, tonne	50,000	60,000	60,000

Source: CCM

Table 6.8-4 Government-subsidized project of Kunming Chuan Jin Nuo, 2020–2022

Year	Project	Subsidy, RMB
2022	Phosphogypsum Research and Development Project (granted by the Science and Technology Department of Guangxi Zhuang Autonomous Region)	332,500

Source: CCM

6.9 Guizhou Chanhen Chemical Corporation

- Basic information

Address: Longchang Town, Fuquan City, Qiannan Buyi and Miao Autonomous Prefecture, Guizhou Province

Tel: +86-0854-2441118

E-mail: chgf@chanhen.com

Website: www.chanphos.com

Guizhou Chanhen Chemical Corporation (Guizhou Chanhen, stock code: 002895.SZ) is a phosphorus chemical technical enterprise, established in 2011 with registered capital of RMB500 million and listed on the Shenzhen Stock Exchange in 2017. Guizhou Chanhen mainly operates in phosphorus ore mining and phosphorus resource deep processing. It has production bases in Fuquan City and Weng'an County of Guizhou Province, Shifang City of Sichuan Province, Fushui County of Guangxi Zhuang Autonomous Region.

Table 6.9-1 Financials of Guizhou Chanhen, 2021–2022, RMB

Year	Total sales	Total operating cost	Gross profit	Year-end total assets
2021	2,530,099,236	2,112,049,311	418,049,925	6,922,942,485
2022	3,447,465,372	2,462,481,093	984,984,279	10,138,442,979

Source: Guizhou Chanhen

Table 6.9-2 PA related subsidiaries of Guizhou Chanhen, as of July 2023

No.	Subsidiary	Ownership percentage
1	Chanhen Eco-technology Co., Ltd.	100.00%
2	Guizhou Chanhen New Energy Material Co., Ltd.	100.00%
3	Guangxi Pengyue Eco-technology Co., Ltd.	90.00%
4	Guizhou Fulin Mining Co., Ltd.	90.00%
5	Guizhou Hention New Energy Material Co., Ltd.	60.00%

Source: CCM

Table 6.9-3 PA Capacity and output of Guizhou Chanhen, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	230,000	230,000	430,000
Output of industrial grade PA, tonne	100,000	100,000	200,000

Source: CCM

Table 6.9-4 Government-subsidized projects of Guizhou Chanhen, 2020–2022

Year	Project	Subsidy, RMB
2021	Phosphogypsum Research and Development Project	16,455,265
2021	200,000 t/a Hemi-dihydrate Wet Process Phosphoric Acid and Deep Processing Project	4,000,000
2021	1,500,000 t/a Medium- and Low-Grade Phosphate Ore Beneficiation Plant Project	2,000,000
2020	Phosphogypsum Research and Development Project	1,409,960
2020	Research Project on the Process of Preparing Plastering Mortar from Hemihydrate Phosphogypsum	100,000

Source: CCM

6.10 Chongqing Chuandong Chemical (Group) Co., Ltd.

- Basic information

Address: 70 Danzishi New Street, Nanan District, Chongqing Municipality

Tel: +86-023-62513822, +86-023-62513986

E-mail: cxd@cd1958.com

Website: www.cd1958.com

Founded in 1979, Chongqing Chuandong Chemical (Group) Co., Ltd. (Chongqing Chuandong) has 13 subsidiaries and four production bases, with over 2,000 employees and 600 engineering technicians. Of the four bases, three located in Chongqing Municipality, Guizhou Province and Guangxi Zhuang Autonomous Region produce phosphoric acid and one in Kaiyang County of Guizhou Province produces polyphosphates.

Chongqing Chuandong's main products include:

- Yellow phosphorus and phosphorus chemicals (phosphorus oxychloride, phosphorus trichloride, phosphoric acid)
- Phosphates (disodium hydrogen phosphate, trisodium phosphate, sodium tripolyphosphate, sodium hexametaphosphate, sodium pyrophosphate, sodium dihydrogen phosphate)
- Formic acids and formates (sodium formate, calcium formate, potassium formate, magnesium formate)

Table 6.10-1 PA related subsidiaries of Chongqing Chuandong, as of July 2023

No.	Subsidiary	Ownership percentage
1	Guizhou Fuquan Chuandong Chemical Co., Ltd.	100.00%
2	Guangxi Liucheng Chuandong Phosphorus Chemical Co., Ltd.	100.00%
3	Chongqing Wansheng Chuandong Chemical Co., Ltd.	96.00%

Source: CCM

Table 6.10-2 PA Capacity and output of Chongqing Chuandong, 2020–2022

Item	2020	2021	2022
Total capacity, t/a	150,000	150,000	150,000
Output of industrial grade PA, tonne	130,000	130,000	130,000
Output of food grade PA, tonne	7,000	8,000	7,000

Source: CCM

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