

China Pentaerythritol Market Research 2024

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Researched & Prepared by:

Kcomber Inc.

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Executive summary

Facing with increasingly stringent environmental standards, high production costs, fierce competition and other factors, China's pentaerythritol industry structure has been continuously optimized and upgraded.

- Production

As the world's largest producer of pentaerythritol, China had 251,900 t/a production capacity as of 2023. In 2023, China's pentaerythritol output was 181,700 tonnes, up 1.6% year on year.

In 2023, there were ten active pentaerythritol producers in China, among which, Hubei Yihua Chemical Industry Co., Ltd. (Hubei Yihua) and Chifeng Ruiyang Chemical Co., Ltd. (Chifeng Ruiyang) were two leading pentaerythritol producers in the domestic market.

- Consumption

In China, pentaerythritol is mainly consumed in the production of alkyd resin, polyurethane, synthetic lubricant, rosin pentaerythritol ester. In 2023, pentaerythritol consumption in the key downstream sector alkyd resin was 67,500 tonnes. It is estimated that the demand from alkyd resin will shrink slowly in the future.

- Import and export

In 2023, China's import volume of pentaerythritol was 7,157 tonnes, up 12.3% year on year, while the export volume was 68,934 tonnes, up 14.9% year on year. Specifically, China exported 64,840 tonnes of monopentaerythritol and 3,915 tonnes of dipentaerythritol, with year-on-year increases of 15.4% and 5.4%, respectively.

South Korea, Brazil and Taiwan Province were the three largest export destinations of China's pentaerythritol by volume, together accounting for 27.6% of the national total export volume in 2023. Sweden was the top import origin of pentaerythritol to China by volume, followed by Taiwan Province and Germany. China's import volume from Sweden accounted for 53.6% of the national total in 2023.

Methodology

- Methodology

The report is drafted by diverse methods as follows:

1) 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 has gone into compilation and analysis of the obtained information. When necessary, checks were made with Chinese pentaerythritol suppliers regarding market information such as key producers, key end-users, production and export and so on.

2) Telephone interview

CCM has carried out extensive telephone interviews in order to grasp the actual market situation of pentaerythritol in China. Interviewees cover:

- Producers
- End users
- Traders
- Associations

3) Internet

CCM contacted with players in this industry through B2B websites.

- Data processing and presentation

The data collected and compiled were sourced from:

- CCM's own database
- Published articles from periodicals, magazines and journals
- Statistics from governments and international institutes
- Telephone interviews with domestic suppliers, end users, government, industrial experts
- Third-party data providers
- Information from the Internet

The data from various sources have been combined and cross-checked to make this report as precise and scientific as possible. Throughout the process, a series of internal discussions were made in order to analyse the data and have conclusions drawn.

- Unit

Tonne: equals to metric ton in this report

/t: per tonne

t/a: tonne/annual, tonne per year

USD: US dollar, currency unit in the US

RMB: currency unit in China, also named yuan

Table 1 Regions covered

Regions covered (Chinese mainland)	Name
Province (22)	Heilongjiang, Jilin, Anhui, Fujian, Liaoning, Hebei, Shandong, Gansu, Qinghai, Henan, Sichuan, Jiangsu, Hubei, Hunan, Jiangxi, Zhejiang, Guangdong, Shaanxi, Hainan, Shanxi, Guizhou, Yunnan
Autonomous region (5)	Guangxi, Inner Mongolia, Tibet, Xinjiang, Ningxia
Municipality (4)	Beijing, Shanghai, Tianjin, Chongqing

Table 2 Exchange rate USD/CNY, Jan. 2019–May 2024

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	6.998	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	6.466	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	7.1283	7.1788	7.1789	7.1778	7.1104	7.0424
2024	7.0770	7.1049	7.1059	7.0938	7.0994	-	-	-	-	-	-	-	-

Source: The People's Bank of China

1 Market situation of pentaerythritol

1.1 Pentaerythritol development in the world

- Supply

Since 2002, the output of pentaerythritol in Europe has been dropping for these reasons: for one thing, consumption of alkyd resin decreased drastically in Europe under stricter environmental requirements; for another, the production cost of pentaerythritol in Europe was quite high.

Along with the fast development of pentaerythritol in China before 2010, pentaerythritol production has shifted to Asia gradually. Due to the high cost of raw materials and environmental protection, some large overseas companies which used to be pentaerythritol producers have turned to purchasing pentaerythritol from Asia. At present, Asia, North America and Europe are the main pentaerythritol production areas in the world.

In 2020, pentaerythritol production was not only affected by the aftermath of COVID-19, but also challenged with factors such as shortage of raw materials, and other natural disasters. For example, there were shortages of raw materials in Europe and Asia, and severe hurricanes in North America after November, which caused tight supply of pentaerythritol. In 2021, the general COVID-19 situation eased, the supply recovered due to resumed production of pentaerythritol producers. However, producers experienced greater cost pressure with jumping prices of raw materials, as well as rising freight and energy costs, which impacted their production to some degree. In 2022, the supply of global pentaerythritol was mainly affected by reduced demand and continuous COVID-19. On the one hand, prolonged conflict between Russia and Ukraine, energy crisis and inflation forced downstream enterprises to reduce production to avoid cost risks, which led to a decline in the demand for pentaerythritol. On the other hand, due to the impacts of COVID-19 and related measures, some enterprises in Asia halted or cut down production sometimes.

Key players in pentaerythritol business outside mainland China include Perstorp Holding AB, Ercros SA, Celanese Corp., Evonik, and LCY Chemical Corp.

Perstorp, the largest pentaerythritol supplier worldwide, strengthened its global supply system of pentaerythritol through production expansion. In 2019, Perstorp planned to build a new 40,000 t/a pentaerythritol production line in India. The same year, Perstorp expanded the effective pentaerythritol production capacity at its Bruchhausen plant in Germany by 12.5%, yet unfortunately, in April 2021, the plant was closed for more than a month due to pressure vessel leakage, which eventually led to a significant drop in the company's pentaerythritol output in H1 2021. In Oct. 2022, PETRONAS Chemicals Group Berhad (PCG) completed the acquisition of Perstorp.

In Feb. 2024, Perstorp's pentaerythritol production line in Sayakha, India was officially inaugurated. This factory is located in a strategic location close to ports, rails and roadways, which can shorten the lead times with about 50% for Asian customers. In Sayakha, Perstorp will produce a pentaerythritol product mix including Perstorp's renewable based, ISCC PLUS-certified grade, Voxtar™, as well as offering monopentaerythritol and Calcium Formate.

- Consumption

Many grades of pentaerythritol are consumed; the most popular one is monopentaerythritol (pure) with a minimum purity of 98%.

As for the downstream, alkyd resin, polyurethane, rosin pentaerythritol ester, tall oil ester and pentaerythritol tetranitrate are the major end-users of pentaerythritol, among which alkyd resin is the largest consumer. Every year, the volume of pentaerythritol consumed in alkyd resin accounts for about 55%–60% of the total consumption globally. The consumption in alkyd resin sector in Europe has seen slower growth in recent years, while that in Asia has been rising. Besides, Asia is the largest pentaerythritol consuming region.

- Price

Till 2008, the global price of pentaerythritol increased year by year and in 2008, the price hit a record high of USD2,300/t. However, the financial crisis that erupted in late 2008 brought down the price.

In 2013, Perstorp raised the price of its pentaerythritol many times.

In 2017, the global price of pentaerythritol continued to increase mainly because of rising raw material costs. During Dec. 2016–March 2018, the price of Perstorp's pentaerythritol in Asian-Pacific region went up by USD370/t. In 2019, the price gradually declined.

In 2020–2021, global price of pentaerythritol witnessed a significant rise, given increased raw materials prices. In addition, rising demand from downstream sectors drove up the price of pentaerythritol. Perstorp, for instance, increased the price of its pentaerythritol in Europe, Middle East and Africa by USD354/t since the beginning of July 2021. And pentaerythritol price in North America rose from USD1,850/t in April 2021 to about USD2,100/t in Dec. 2021.

In Q1 2022, global pentaerythritol prices continued to increase. However, in H2 2022, the price was on a continuous decline, mainly due to lower cost of methanol, and the affected demand against the energy crisis caused by the Russia-Ukraine conflict.

In 2023, due to the decline in upstream raw material prices and depressed demand in downstream ink and coating industries, coupled with high inflation suppressing investment and consumption, the global price of pentaerythritol was generally on a downward trend.

1.2 Pentaerythritol development in China

Table 1.2-1 Pentaerythritol development in China

Development stage of pentaerythritol	Main event
Beginning stage (1957–1989)	In 1957, Shanghai Reagent Factory initiated the production of pentaerythritol in China, and its output was 20 tonnes at that time. By 1986, the output of pentaerythritol in China reached 14,000 tonnes.
Growth stage (1990–2007)	<p>1990–1998 Driven by the ever-increasing import volume, some domestic production lines were established, but their capacity of pentaerythritol was small, with a maximum volume of less than 5,000 t/a. By the end of 1997, there had been 29 pentaerythritol producers in China, and the total capacity of the active producers was 52,000 t/a, with the operating rate of no more than 58%.</p> <p>1999–2002 By 2002, the number of pentaerythritol producers was reduced to 20, and the total output and apparent consumption of pentaerythritol in China were 51,000 tonnes and 60,000 tonnes, increasing by 299% and 376% respectively over 1990. The annual import volume was around 7,500 tonnes–10,500 tonnes, while the export volume was less than 300 tonnes.</p> <p>2003–2007 The total capacity of pentaerythritol rose to 167,000 t/a in 2007 from 99,000 t/a in 2003. The operating rate in this period was around 70%–100% and the domestic apparent consumption volume was more than 100,000 tonnes in 2005. In addition, the export volume increased sharply, reaching 46,000 tonnes in 2007, with a CAGR of 55.6% in 2003–2007. Since 2003, China has become a net exporter of pentaerythritol.</p>
Mature stage (2008–2023)	<p>2008–2014 The annual domestic output of pentaerythritol slowed down its growth in this period. And during this time, pentaerythritol production in China started to be concentrated in several major manufacturers, while other manufacturers suspended production or even exited. The export volume of pentaerythritol fluctuated between 52,000 tonnes and 66,000 tonnes in 2008–2013. In 2014, the export slumped to 43,400 tonnes, the lowest since 2008. By contrast, the import volume of pentaerythritol maintained at no more than 3,000 tonnes in this period. Asia was the major market of China's pentaerythritol, and its share in total export volume increased from 35% in 2010 to 49% in 2014.</p> <p>2015–2023 The output of pentaerythritol plunged in 2014, and further dropped by 9.0% year on year to 171,500 tonnes in 2015. Although it recovered slightly in 2016 thanks to improved overall situation in chemical industry, the output kept decreasing in 2017–2020. In 2018–2019, two major pentaerythritol producers in China suspended parts of their production lines, and in 2020, the industry was affected by COVID-19, with exports slashed to less than 50,000 tonnes. As the COVID-19 situation eased in 2021, strong demand boosted the output of pentaerythritol significantly, and China's exports of pentaerythritol increased greatly during the year. In 2021, the capacity of pentaerythritol in China increased to 263,900 t/a, as there were two new entrants into this industry. In 2022, national capacity of pentaerythritol dropped to 251,900 t/a, and pentaerythritol export decreased because of reduced demand. In 2023, the capacity of pentaerythritol in China remained unchanged, but the export volume reached a record high of 68,934 tonnes.</p>

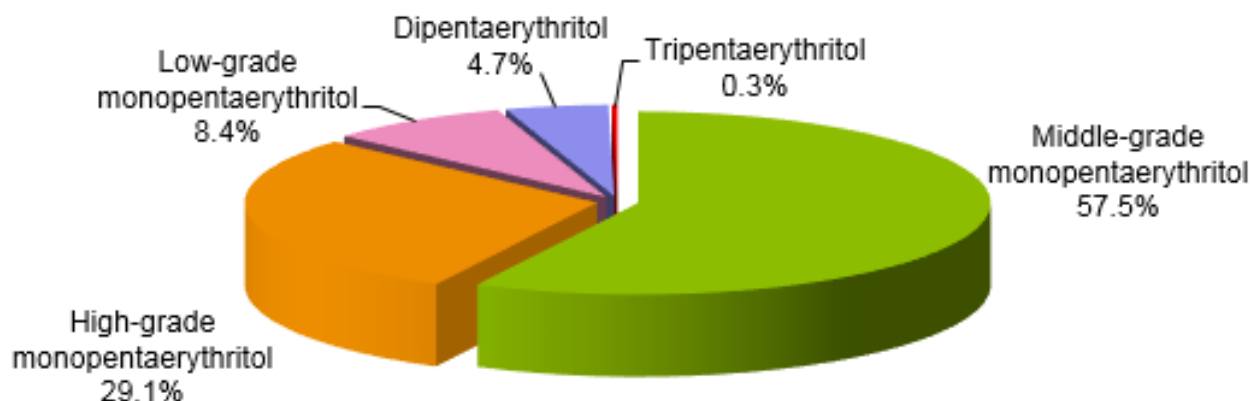
Source:CCM

1.3 Product types of pentaerythritol

Pentaerythritol can be classified as follows:

- Low-grade monopentaerythritol: 93% max.
- Middle-grade monopentaerythritol: 94%–97%
- High-grade monopentaerythritol: 98% min.
- Dipentaerythritol: 85% or 90%
- Tripentaerythritol

Figure 1.3-1 Product structure of pentaerythritol in China by capacity, 2023



Source:CCM

- Monopentaerythritol

Nearly 95% pentaerythritol produced in China is monopentaerythritol, which is mainly consumed in alkyd resin, polyurethane, rosin pentaerythritol ester and lubricant.

Capacity of most pentaerythritol producers in China has remained unchanged since 2015, but there were changes as the following:

- Hubei Yihua Chemical Industry Co., Ltd. cut its pentaerythritol capacity by 8,000 t/a to 70,000 t/a in 2017.
- Chifeng Ruiyang Chemical Co., Ltd. (Chifeng Ruiyang) and Jiangsu Kailin Ruiyang Chemical Co., Ltd. (Jiangsu Ruiyang, the former parent company of Chifeng Ruiyang) cut their combined capacity by 60,000 t/a to 60,000 t/a in 2018, by 15,000 t/a to 45,000 t/a in 2019. In Nov. 2019, Chifeng Ruiyang was acquired by Guizhou Zhongyida Co., Ltd.; Chifeng Ruiyang's capacity of pentaerythritol further reduced by 2,000 t/a to 43,000 t/a in 2020 and its capacity was kept at 43,000 t/a in the past three years.
- Ningxia Ningshun New Material Technology Co., Ltd.'s 20,000 t/a pentaerythritol project and Shandong Xinzhiyuan Chemical Co., Ltd.'s 30,000 t/a pentaerythritol project were put into trial production in Oct. and Nov. 2021, respectively.
- Baoding Guoxiu Chemical Co., Ltd. (Baoding Guoxiu) suspended production of pentaerythritol in Oct. 2016 because of environmental problems, and it dismantled production equipment in April 2020. Moreover, Shandong IFT Science & Technology Co., Ltd. (Shandong IFT) stopped production of pentaerythritol in 2022.

- Dipentaerythritol

Dipentaerythritol is used for the production of high-performance paint and aviation lubricant.

Although many producers claim that they have the ability to produce dipentaerythritol, the actual production scale is still small. In 2023, there were ten dipentaerythritol producers in China with a total capacity of 12,400 t/a. Chifeng Ruiyang, with 2,500 t/a production capacity, is the largest dipentaerythritol producer in China.

In the long term, dipentaerythritol will be well developed in China. It is forecasted that more and more manufacturers will invest in dipentaerythritol production to earn more profits.

- Tripentaerythritol

Tripentaerythritol is used for antifoaming coating, lubricant for vehicle and motors. Up till April 2024, there were only two tripentaerythritol producers in China—Chifeng Ruiyang (200 t/a) and Puyang Yongan Chemical Co., Ltd. (500 t/a).

The optimal feedstock ratio for the preparation of tripentaerythritol is:
Formaldehyde (10%–30%): acetaldehyde: caustic soda = 4.2:1:1.15–1.25 (mol/mol)

The total yield is 95% min., including 8% min. of tripentaerythritol.

2 Production of pentaerythritol in China (2023–H1 2024)

2.1 Supply of major raw materials of pentaerythritol

Major raw materials for pentaerythritol production in China include methanol, formaldehyde, acetaldehyde, sodium hydroxide and sulfuric acid. These raw materials are fairly abundant in China, so the production of pentaerythritol is much more affected by its demand and price than by the supply of its raw materials.

Table 2.1-1 Unit consumption of major raw materials for pentaerythritol production in China

Raw material	Specification	Unit consumption, kg/t
Methanol	98%	1,300–1,350
Formaldehyde	37%	2,880–2,950
Acetaldehyde	98%	350–365
Sodium hydroxide	Technical	255
Sulfuric acid	30%	774

Source:CCM

- Methanol

From 2019 to 2023, both the supply (capacity and output) and demand of methanol in China kept increasing year by year.

Table 2.1-2 Production, import, export and apparent consumption of methanol in China, 2019–2023

Year	Capacity, t/a	Output, tonne	Import volume, tonne	Export volume, tonne	Apparent consumption, tonne
2019	74,670,000	62,157,400	10,895,900	171,000	72,882,300
2020	90,425,000	63,570,000	13,008,957	89,106	76,489,852
2021	93,445,000	75,301,800	11,197,992	392,841	86,106,951
2022	100,410,000	80,225,000	12,192,953	172,820	92,245,133
2023	106,186,000	83,173,000	14,552,908	149,179	97,576,730

Note: Apparent consumption=Output+Import-Export

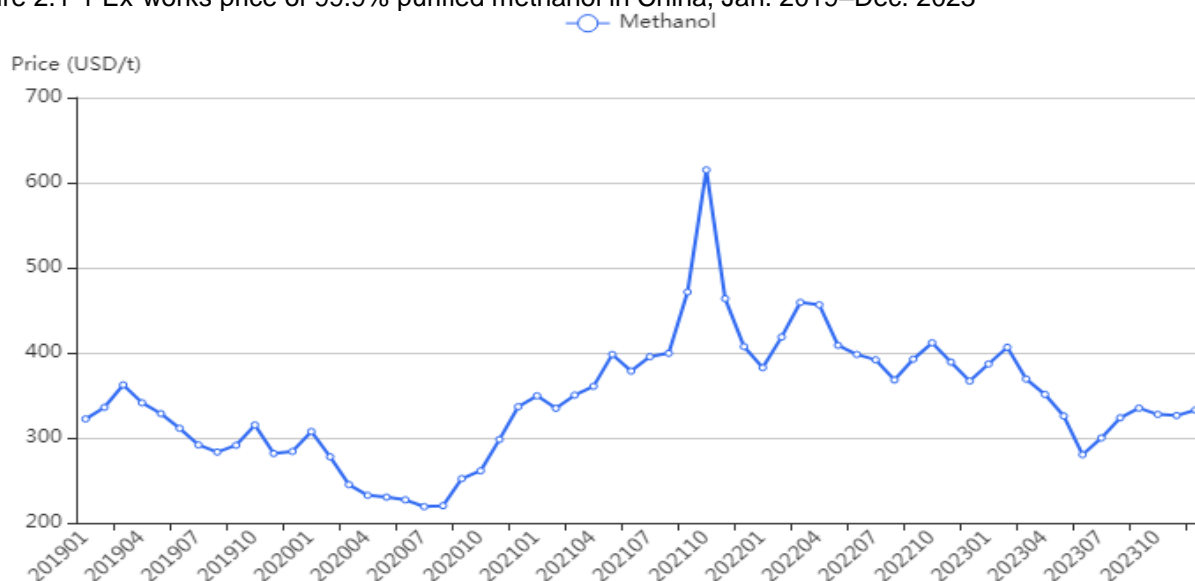
Source:China Customs & CCM

From 2019 to July 2020, the price of methanol fluctuated and decreased. The lowest price appeared in July 2020, at USD219.12/t, which was also the lowest price in the past five years.

Since Aug. 2020, supported by recovery of the global economy and the demand, the price of methanol went upward and kept growing; it hit the highest record in Oct. 2021, at USD615/t, affected by energy shortage. Then the price fell back quickly. In 2022, the methanol price fluctuated between USD360/t and USD460/t, still at a relatively high level on the whole.

In 2023, the overall methanol price showed a V-shaped trend. In H1 2023, coal was in a low season, so coal price declined, which drove down the production cost and price of methanol. In H2, methanol price briefly increased and remained stable after Sept., following coal price changes due to coal mine safety inspections and production restrictions in Q3 and stable supply-demand relation in Q4.

Figure 2.1-1 Ex-works price of 99.9% purified methanol in China, Jan. 2019–Dec. 2023



Source:CCM

- Formaldehyde

Generally speaking, formaldehyde is a basic and low value-added chemical. As liquid formaldehyde is inconvenient to transport, formaldehyde is usually consumed in places close to its producing areas in order to reduce freight charges. And both the import and export volume of the product in China are quite small.

In 2019, the output of formaldehyde in China stood at 13,100,000 tonnes. But it declined by 9.2% year on year in 2020 as demand from downstream real estate and other industries reduced due to the COVID-19.

In 2021, the supply and demand of formaldehyde recovered, leading to a significant year-on-year increase in the output of formaldehyde in China. In 2022, the concentration of the formaldehyde industry increased. With improved operation stability of large-scale enterprises, the supply of formaldehyde was relatively abundant.

In 2023, the capacity of formaldehyde in China continued to expand, reaching 43,670,000 t/a, with output rising by 2.5% year on year. The increase in capacity reeled from chemical enterprises' increasing attention to the construction of up- and downstream industrial chains to reduce the production cost, which has led to the growing installation of formaldehyde production lines for downstream products.

Table 2.1-3 Production, import, export and apparent consumption of formaldehyde in China, 2019–2023

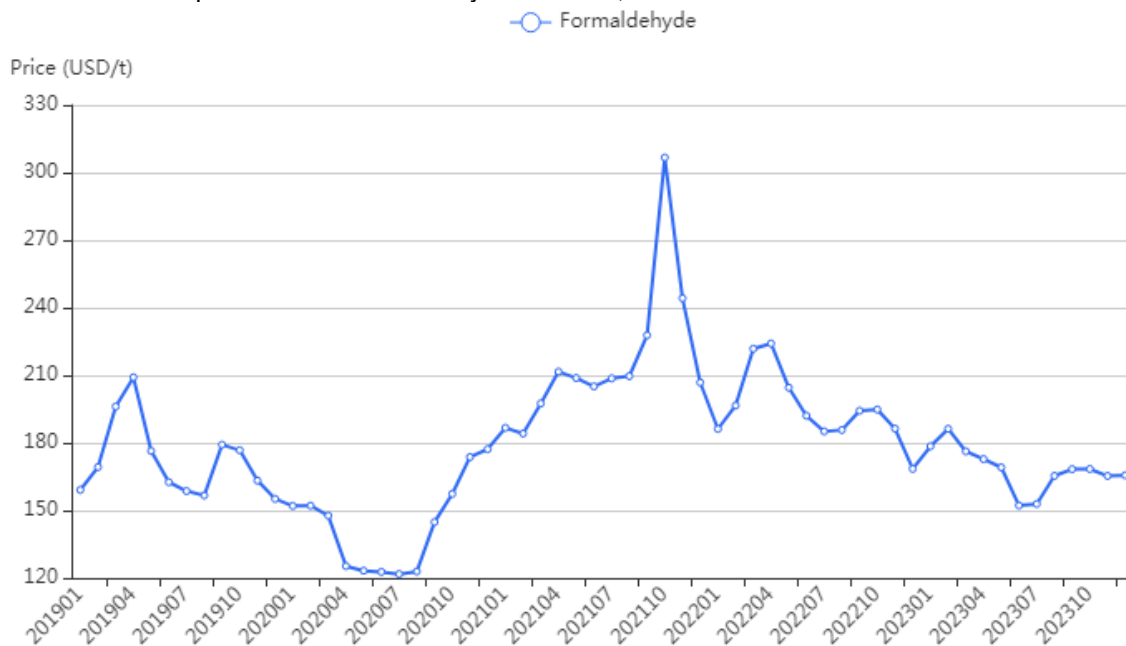
Year	Capacity, t/a	Output, tonne	Import volume, tonne	Export volume, tonne	Apparent consumption, tonne
2019	36,000,000	13,100,000	3	11,768	13,088,234
2020	36,000,000	11,900,000	5	12,537	11,887,468
2021	37,010,000	14,580,000	2	4,243	14,575,759
2022	39,770,000	15,908,000	16	1,347	15,906,670
2023	43,670,000	16,310,000	2	1,598	16,308,404

Note: Apparent consumption=Output+Import-Export
Source:China Customs & CCM

The price of formaldehyde is primarily decided by methanol price, because the cost of methanol, the key raw material of formaldehyde, accounts for around 90% of the total production cost of formaldehyde in China.

The price of formaldehyde fluctuated along with that of methanol. In 2019, the ex-works price of formaldehyde presented large fluctuations in H1, then after a bump in Q3, kept falling through H1 2020, decreasing from USD209/t in April 2019 to USD122/t in July 2020. After that, it quickly bounced back and rocketed to USD307/t in Oct. 2021. However, the price soon plunged to USD186/t in Jan. 2022. It recovered to USD224/t in April 2022, but during the rest months of 2022, the price showed an overall downward trend. In 2023, the price of formaldehyde slightly increased at the beginning of year, after which a V-shaped trajectory was seen, reaching a bottom price of USD152/t in June and then quickly rebounding, plateauing after Aug.

Figure 2.1-2 Ex-works price of 37% formaldehyde in China, Jan. 2019–Dec. 2023



Source:CCM

- Acetaldehyde

Acetaldehyde is an important intermediate of organic chemical products. As its boiling point is only 20.8° C, acetaldehyde is difficult to transport and typically produced in places close to where it is used.

Acetaldehyde is mainly used to produce acetic acid. However, the growth of acetaldehyde consumption in this end-use segment will slow down in the future because any new acetic acid plant will be based on the methanol carbonylation process, and little acetaldehyde will be used for acetic acid production.

The import and export volume of acetaldehyde are very small, and generally its domestic output can satisfy domestic demand.

- Sodium hydroxide and sulfuric acid

China's sodium hydroxide output kept increasing in 2019–2023. In 2023, China produced 41,014,000 tonnes of sodium hydroxide in total, up by 3.0% year on year.

From 2019 to 2023, sulfuric acid output remained steadily increasing due to the growth in downstream fertilizer and industrial demand. The output increased to 95,800,000 tonnes in 2023, edging up by 0.8% year on year.

Table 2.1-4 Production, import, export and apparent consumption of sodium hydroxide in China, 2019–2023

Year	Output, tonne	Import volume, tonne	Export volume, tonne	Apparent consumption, tonne
2019	34,642,000	28,157	761,741	33,908,415
2020	36,739,000	19,233	750,704	36,007,530
2021	38,913,000	24,899	737,819	38,200,080
2022	39,805,000	8,291	1,436,887	38,376,404
2023	41,014,000	13,648	1,155,403	39,872,245

Note: 1. Apparent consumption=Output+Import-Export

2. The data of output, import and export are calculated by 100% active ingredient.

Source: NBS & China Customs & CCM

Table 2.1-5 Production, import, export and apparent consumption of sulfuric acid in China, 2019–2023

Year	Output, tonne	Import volume, tonne	Export volume, tonne	Apparent consumption, tonne
2019	89,357,000	530,538	2,174,783	87,712,800
2020	92,382,000	636,224	1,722,952	91,295,271
2021	93,827,000	414,269	2,840,301	91,400,968
2022	95,046,000	275,264	3,642,918	91,678,347
2023	95,800,000	322,001	2,507,195	93,614,806

Note: 1. Apparent consumption=Output+Import-Export

2. The data of output, import and export are calculated by 100% active ingredient.

Source: NBS & China Customs & CCM

2.2 Price of pentaerythritol

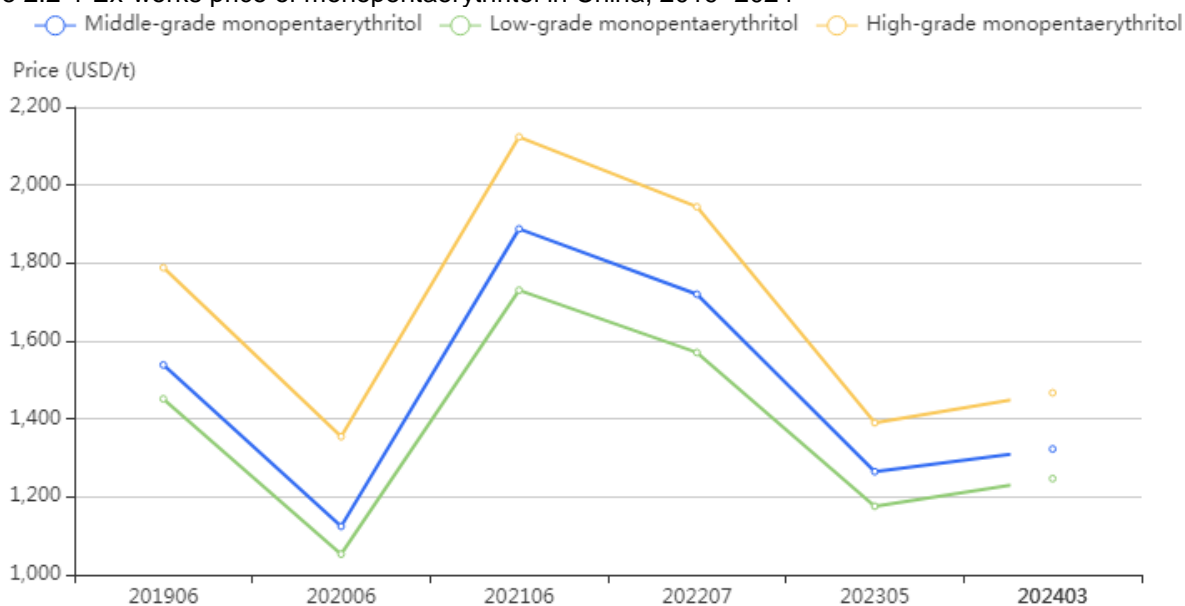
- Price of monopentaerythritol

In recent five years, China's ex-works prices of monopentaerythritol substantially fluctuated but basically remained under USD2,200/t.

From 2019 to H1 2020, the ex-works prices of monopentaerythritol in China decreased a lot, influenced by decreasing prices of raw materials. Up to June 2021, with recovered economy, the price rebounded rapidly.

From H2 2021 to H1 2022, domestic ex-works prices of monopentaerythritol decreased mainly due to weak downstream demand, even though raw material prices remained at a high level. Up to May 2023, monopentaerythritol prices fell further due to a slow recovery in demand. From H2 2023 to March 2024, the price of monopentaerythritol slightly increased due to the impact of rising raw material prices.

Figure 2.2-1 Ex-works price of monopentaerythritol in China, 2019–2024



Source:CCM

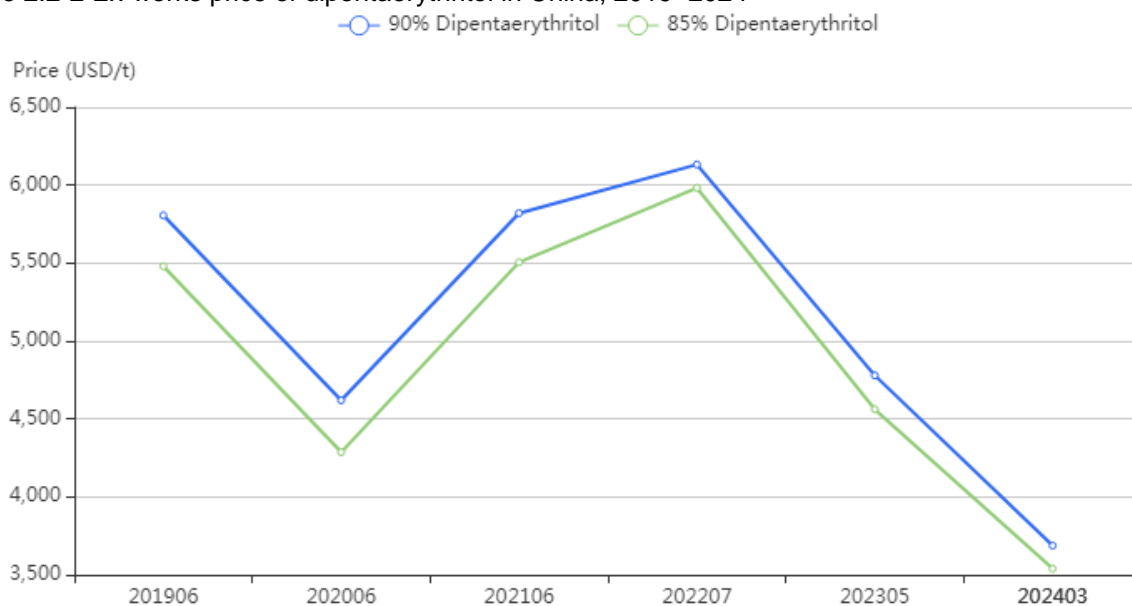
- Price of dipentaerythritol

In 2019 to June 2020, due to the COVID-19 pandemic, downstream demand shrank, and the ex-works prices of 85% and 90% dipentaerythritol declined to USD4,287/t and USD4,619/t respectively.

As the global economy recovered, the demand for dipentaerythritol increased and the prices recorded in June 2021 returned to the level seen in 2017–2019. This upward trend continued as of July 2022.

In H2 2022, due to worsened COVID-19 situation in China, downstream demand for dipentaerythritol declined. Since 2023, despite China's deregulation of the COVID-19, the downstream demand for dipentaerythritol has not been restored as expected. Until March 2024, the price of dipentaerythritol continued to decline.

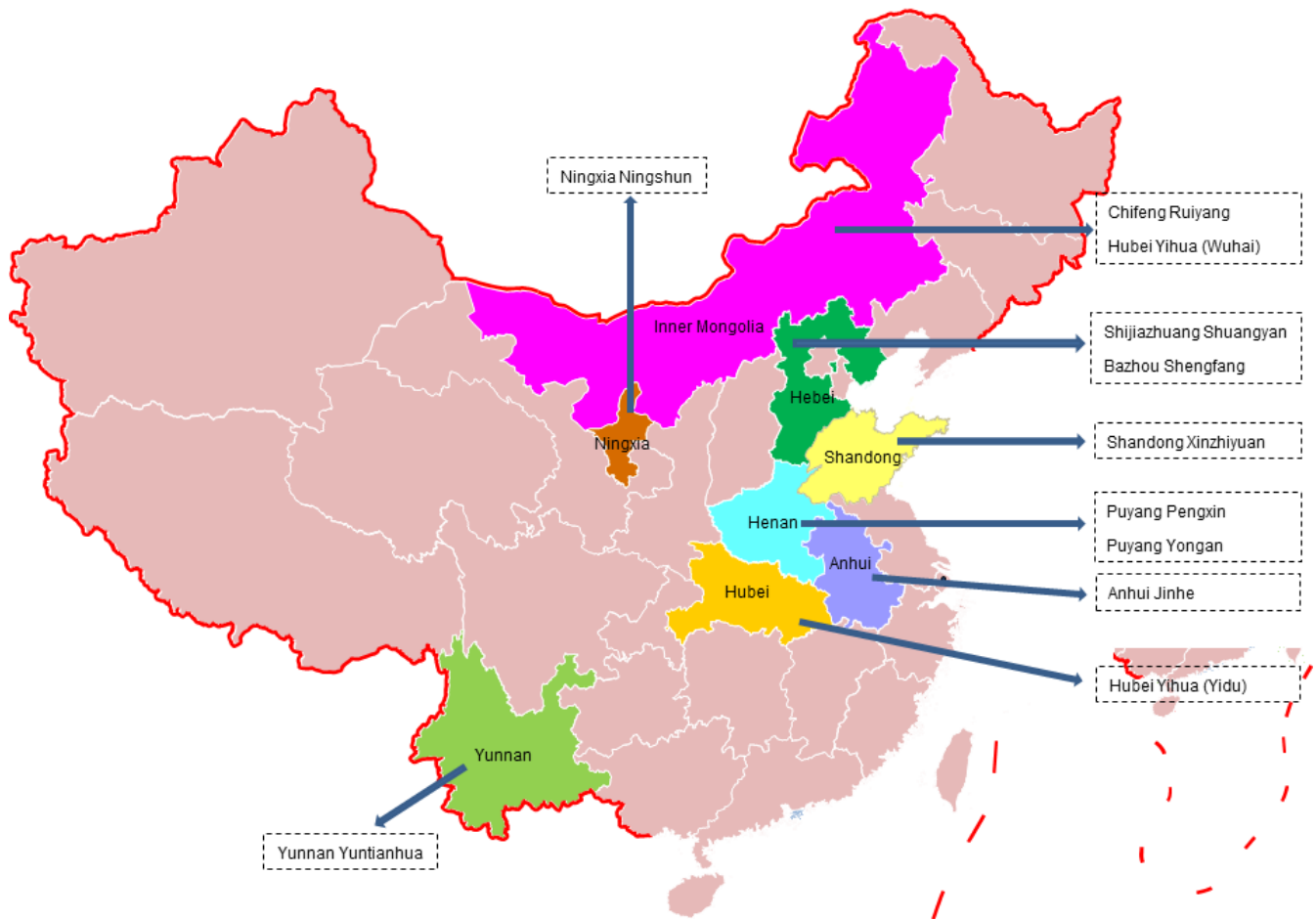
Figure 2.2-2 Ex-works price of dipentaerythritol in China, 2019–2024



Source:CCM

2.3 Geographical distribution of producers

Figure 2.3-1 Geographical distribution of pentaerythritol producers in China, 2023



Note: Hubei Yihua has two production bases producing pentaerythritol; one is located in Yidu City of Hubei Province and the other in Wuhai City of Inner Mongolia Autonomous Region.

Source: CCM

Table 2.3-1 Capacity and output of pentaerythritol producers in China, 2023

Producer	Capacity, t/a	Output, tonne		
		Mono-	Di-	Tri-
Chifeng Ruiyang	45,500	46,470	2,200	130
Hubei Yihua (Yidu)	40,000	32,200	900	0
Hubei Yihua (Wuhai)	30,000	23,900	0	0
Puyang Pengxin	20,000	18,900	600	0
Anhui Jinhe	20,000	18,340	460	0
Yunnan Yuntianhua	11,400	12,870	230	0
Puyang Yongan	10,000	4,200	280	120
Shijiazhuang Shuangyan	10,000	6,550	250	0
Bazhou Shengfang	15,000	700	0	0
Shandong Xinzhiyuan	30,000	6,700	300	0
Ningxia Ningshun	20,000	5,200	200	0

*Note: The capacity of pentaerythritol in Chifeng Ruiyang is the sum of monopentaerythritol capacity and dipentaerythritol capacity.
Source:CCM*

2.4 Production of pentaerythritol

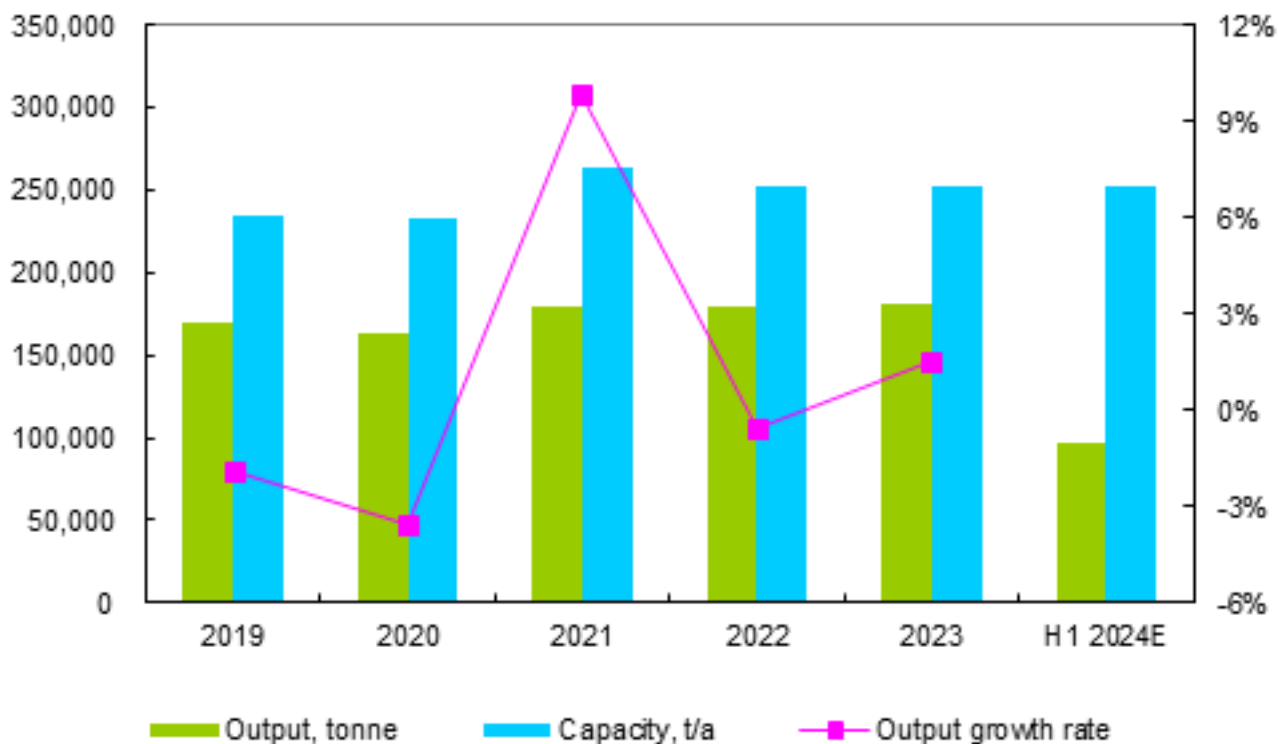
In 2019, the capacity of pentaerythritol in China was 234,500 t/a, but decreased to 232,500 t/a in 2020, because Chifeng Ruiyang Chemical Co., Ltd. stopped part pentaerythritol capacity. Meanwhile, domestic manufacturers maintained stable production due to stable demand (especially overseas demand for dipentaerythritol), despite high raw material prices and strict environmental protection inspections.

In 2021, China's pentaerythritol production capacity jumped to 263,900 t/a, boosted by the 20,000 t/a and 30,000 t/a production lines of Ningxia Ningshun New Material Technology Co., Ltd. and Shandong Xinzhiyuan Chemical Co., Ltd., respectively, which were put into trial production in Q4 2021. The output of pentaerythritol also witnessed a significant increase this year thanks to strong demand. In 2022, with elimination of ineffective capacity, the national capacity of pentaerythritol decreased to 251,900 t/a; the output of pentaerythritol saw a negative growth, at an annual rate of -0.5%.

In 2023, the production capacity of pentaerythritol in China remained stable, with potential production capacity still under construction. However, due to China's deregulation of COVID-19 and Chinese manufacturers' efforts to tap into overseas markets, China's pentaerythritol exports increased by 14.9% year on year, while its output increased by 1.6% year on year to 181,700 tonnes. The increase in production couldn't match the spike in export volume, mainly due to the active consumption of accumulated inventory by manufacturers in 2022. For example, Chifeng Ruiyang reported a 20.5% year-on-year decrease in pentaerythritol inventory in 2023.

Dipentaerythritol and tripentaerythritol are byproducts from the production of monopentaerythritol. Only Chifeng Ruiyang has a dedicated dipentaerythritol production line, so basically, the capacity of monopentaerythritol can be regarded as that of pentaerythritol. The output of dipentaerythritol is determined by that of monopentaerythritol.

Figure 2.4-1 Capacity and output of pentaerythritol in China, 2019–H1 2024



Note: The output in H1 2024 is an estimate.

Source: CCM

Table 2.4-1 Output of monopentaerythritol, dipentaerythritol and tripentaerythritol in China, 2019–H1 2024, tonne

Year	Monopentaerythritol	Dipentaerythritol	Tripentaerythritol
2019	165,750	3,800	150
2020	159,500	4,050	130
2021	174,800	4,950	130
2022	173,620	5,100	180
2023	176,030	5,420	250
H1 2024E	94,655	2,730	115

Note: The outputs in H1 2024 are estimates.

Source: CCM

Table 2.4-2 Basic information of pentaerythritol producers in China

No.	Producer	Abbreviation	Location
1	Hubei Yihua Chemical Industry Co., Ltd.	Hubei Yihua	Yidu City, Hubei Province; Wuhai City, Inner Mongolia Autonomous Region
2	Chifeng Ruiyang Chemical Co., Ltd.	Chifeng Ruiyang	Chifeng City, Inner Mongolia Autonomous Region
3	Puyang Pengxin Chemical Co., Ltd.	Puyang Pengxin	Puyang City, Henan Province
4	Anhui Jinhe Industrial Co., Ltd.	Anhui Jinhe	Chuzhou City, Anhui Province
5	Yunnan Yuntianhua Co., Ltd.	Yunnan Yuntianhua	Shuifu County, Yunnan Province
6	Puyang Yongan Chemical Co., Ltd.	Puyang Yongan	Puyang City, Henan Province
7	Shijiazhuang Shuangyan Chemical Co., Ltd.	Shijiazhuang Shuangyan	Shijiazhuang City, Hebei Province
8	Bazhou Shengfang United Chemical Co., Ltd.	Bazhou Shengfang	Bazhou City, Hebei Province
9	Shandong Xinzhiyuan Chemical Co., Ltd.	Shandong Xinzhiyuan	Heze City, Shandong Province
10	Ningxia Ningshun New Material Technology Co., Ltd.	Ningxia Ningshun	Yinchuan City, Ningxia Hui Autonomous Region

Source:CCM

In 2023, there were ten active monopentaerythritol producers in China with a total capacity of 249,400 t/a.

Hubei Yihua, the biggest player in the pentaerythritol industry in China, cut its capacity by 8,000 t/a to 70,000 t/a in 2017. It stopped manufacturing pentaerythritol in its Yichang factory because of the upgrading of its synthetic ammonia installation. The company focuses on the manufacturing of 95% and 98% monopentaerythritol to fulfil larger market demand for high-end products. It continues the production of dipentaerythritol with a small amount.

Table 2.4-3 Capacity of monopentaerythritol producers in China, 2021–H1 2024, t/a

No.	Producer	Status, 2023	Low-grade				Middle-grade				High-grade				Total			
			2021	2022	2023	H1 2024E*3	2021	2022	2023	H1 2024E	2021	2022	2023	H1 2024E	2021	2022	2023	H1 2024E
1	Hubei Yihua*1	Active	0	0	0	0	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	70,000	70,000	70,000	70,000
2	Chifeng Ruiyang*2	Active	0	0	0	0	26,000	26,000	26,000	26,000	17,000	17,000	17,000	17,000	43,000	43,000	43,000	43,000
3	Puyang Pengxin	Active	9,000	9,000	9,000	9,000	5,000	5,000	5,000	5,000	6,000	6,000	6,000	6,000	20,000	20,000	20,000	20,000
4	Anhui Jinhe	Active	5,000	5,000	5,000	5,000	10,000	10,000	10,000	10,000	5,000	5,000	5,000	5,000	20,000	20,000	20,000	20,000
5	Yunnan Yuntianhua	Active	0	0	0	0	0	0	0	0	11,400	11,400	11,400	11,400	10,000	11,400	11,400	11,400
6	Puyang Yongan	Active	0	0	0	0	10,000	10,000	10,000	10,000	0	0	0	0	10,000	10,000	10,000	10,000
7	Shijiazhuang Shuangyan	Active	0	0	0	0	10,000	10,000	10,000	10,000	0	0	0	0	10,000	10,000	10,000	10,000
8	Bazhou Shengfang	Active	8,000	8,000	8,000	8,000	5,000	5,000	5,000	5,000	2,000	2,000	2,000	2,000	15,000	15,000	15,000	15,000
9	Shandong Xinzhiyuan	Active	0	0	0	0	30,000	30,000	30,000	30,000	/	0	0	0	30,000	30,000	30,000	30,000
10	Ningxia Ningshun	Active	0	0	0	0	20,000	20,000	20,000	20,000	/	0	0	0	20,000	20,000	20,000	20,000
Others			0	0	0	0	2,000	0	0	0	10,000	0	0	0	12,000	0	0	0
Total			22,000	22,000	22,000	22,000	153,000	151,000	151,000	151,000	86,400	76,400	76,400	76,400	261,400	249,400	249,400	249,400

Note:*1. Hubei Yihua now has two production bases producing pentaerythritol: Hubei Yihua (Yidu) and Hubei Yihua (Wuhai). Hubei Yihua (Yichang), previously also a pentaerythritol base has stopped pentaerythritol production.

*2. Chifeng Ruiyang is no longer a subsidiary of Jiangsu Kailin Ruiyang Chemical Co., Ltd. It now becomes a subsidiary of Guizhou Zhongyida Co., Ltd. through acquisition. Besides, Jiangsu Ruiyang and Guizhou Kailin have stopped pentaerythritol production.

*3. The outputs in H1 2024 are estimates.

Source:CCM

So far in H1 2024, there are ten active dipentaerythritol producers in China, with total capacity of 12,400 t/a.

At the end of 2020, Yunnan Yuntianhua completed its pentaerythritol technical transformation project, which eliminated the capacity for 93% pentaerythritol and adjusted its pentaerythritol production equipment to produce 90% dipentaerythritol with 600 t/a capacity, and 98% and 99% monopentaerythritol with the total capacity of 11,400 t/a.

Dipentaerythritol used to be merely a byproduct of monopentaerythritol, but has become a critical part of manufacturers' product portfolio now. Chifeng Ruiyang and Anhui Jinhe have successfully developed synthetic method for dipentaerythritol, and many other companies are paying attention to the R&D.

China's dipentaerythritol output increased from 4,050 tonnes in 2020 to 5,100 tonnes in 2022, largely driven up by huge domestic and overseas demand. In 2023, thanks to the increase in export demand, the output of dipentaerythritol increased by 6.3% year-on-year, reaching 5,420 tonnes.

Table 2.4-4 Capacity and output of dipentaerythritol producers in China, 2021–H1 2024

No.	Producer	Capacity H1 2024, t/a	Output, tonne			
			2021	2022	2023	H1 2024E*2
1	Chifeng Ruiyang	2,500	2,000	2,100	2,200	1,100
2	Hubei Yihua*1	2,400	700	700	900	400
3	Puyang Pengxin	1,000	700	700	600	300
4	Anhui Jinhe	1,000	450	450	460	220
5	Yunnan Yuntianhua	600	150	200	230	160
6	Puyang Yongan	2,000	450	300	280	140
7	Shijiazhuang Shuangyan	500	300	250	250	130
8	Bazhou Shengfang	400	0	0	0	0
9	Shandong Xinzhiyuan	1,000	200	250	300	160
10	Ningxia Ningshun	1,000	100	150	200	120
	Others	0	0	0	0	0
	Total	12,400	4,950	5,100	5,420	2,730

Note:*1. Hubei Yihua has two production bases producing pentaerythritol, including Hubei Yihua (Yidu) and Hubei Yihua (Wuhai).

*2. The outputs in H1 2024 are estimates.

Source:CCM

There are also some new pentaerythritol capacities upcoming in China.

- Shandong Xinzhiyuan's 30,000 t/a pentaerythritol project (phase II)
- Puyang Runfeng Chemical Technology Co., Ltd.'s 20,000 t/a pentaerythritol project
- Kuitun Zhongneng New Material Technology Co., Ltd.'s 30,000 t/a pentaerythritol project
- Yulin Baijiarui Fine Chemical Co. Ltd.'s 80,000 t/a pentaerythritol project

2.5 Summary of Chinese manufacturers and five major producers of pentaerythritol

In 2023, all the ten active Chinese pentaerythritol manufacturers had capacity of at least 10,000 t/a. The combined capacity of the top two was 115,500 t/a. From 2021 to 2023, capacity in most pentaerythritol producers scarcely changed, except that Yunnan Yuntianhua adjusted its capacity from 10,000 t/a to 11,400 t/a in 2021.

In 2021, the competitive landscape of the domestic pentaerythritol industry had changed greatly due to the entry of two new players Shandong Xinzhiyuan and Ningxia Ningshun. The shares of China's top two pentaerythritol producers to the national total, in terms of both capacity and output, decreased compared with those of 2020.

In 2022, there was a slight concentration in the pentaerythritol industry, due to the reduction of production capacity in Shandong IFT. The shares of capacity and output in China's top two pentaerythritol producers to the national total slightly increased.

In 2023, the capacity and output shares of the two leading producers remained almost unchanged compared to 2022, and those of the top five producers also remained stable.

Table 2.5-1 Capacity and share of main pentaerythritol manufacturers in China, 2021–2023

Item	Capacity, 2023		Capacity, 2022		Capacity, 2021	
	Volume, t/a	Share	Volume, t/a	Share	Volume, t/a	Share
Top two	115,500	45.9%	115,500	45.9%	115,500	43.8%
Top five	185,500	73.6%	185,500	73.6%	185,500	70.3%
Total	251,900	100.0%	251,900	100.0%	263,900	100.0%

Note: Ranking is determined by capacity.
Source: CCM

Table 2.5-2 Output and share of main pentaerythritol manufacturers in China, 2021–2023

Item	Output, 2023		Output, 2022		Output, 2021	
	Volume, tonne	Share	Volume, tonne	Share	Volume, tonne	Share
Top two	105,800	58.2%	104,000	58.1%	104,000	57.8%
Top five	157,200	86.5%	155,000	86.6%	152,750	84.9%
Total	181,700	100.0%	178,900	100.0%	179,880	100.0%

Note: Ranking is determined by output.
Source: CCM

- Raw material situation of top 5 pentaerythritol manufacturers

Table 2.5-3 Methanol and acetaldehyde situation of top five manufacturers

Raw material	Specification	Producer	Source	Capacity in 2023, t/a	Purchase volume in 2023, tonne	Price in March 2024, USD/t
Methanol	99.0%	Hubei Yihua	Itself	90,000	72,000	/
		Anhui Jinhe	Itself	80,000	/	/
		Chifeng Ruiyang	Outsourcing	/	70,700	286
		Puyang Pengxin	Outsourcing	/	26,800	326
		Shandong Xinzhiyuan	Outsourcing	/	9,200	328
Acetaldehyde	99.8%	Hubei Yihua	Itself	20,000	/	/
		Chifeng Ruiyang	Itself	24,000	/	/
		Anhui Jinhe	Itself	12,000	/	/
		Puyang Pengxin	Outsourcing	/	6,800	1,267
		Shandong Xinzhiyuan	Outsourcing	/	2,700	1,267

Note: On 3 Jan., 2024, the relocation of Hubei Yihua's 90,000 t/a methanol plant was completed and put into production.
Source:CCM

Table 2.5-4 Average market price of ethanol at the locations of top two producers, 2023

No.	Producer	Location	Average market price, USD/t
1	Hubei Yihua	Hubei	1,062
2	Chifeng Ruiyang	Inner Mongolia	1,118

Note: The raw material of Chifeng Ruiyang's acetaldehyde is ethanol, which is made by purchased corn. Average market price of corn in Inner Mongolia was USD0.39/kg in 2023.
Source:CCM

2.6 Energy prices in 2023

In 2023, global economic growth slowed down, and the impact of geopolitics on the supply situation weakened, so international energy prices fell. In China, coal mining production was booming and coal imports increased. In addition, due to the impact of long-term contract signing, coal demand was stable, leading to a short-term oversupply situation and a fluctuating downward trend in coal prices. And domestic natural gas prices also significantly declined due to the impact of international price declines. The decrease in energy prices undoubtedly reduces the production cost of pentaerythritol and to some extent drives the decline in pentaerythritol prices. Given the abundant coal supply and low prices of coal power, compared to other regions, pentaerythritol producers in Inner Mongolia maintain a comparative advantage in terms of production cost.

Table 2.6-1 Energy market prices at locations of these Chinese pentaerythritol producers, 2023

No.	Producer	Location	Average market price of electricity, USD/kWh	Method of steam generation	Average market price of coal, USD/t	Average market price of gas, USD/m ³
1	Hubei Yihua Chemical Industry Co., Ltd.	Hubei	0.0717	Coal	110.19	/
2	Chifeng Ruiyang Chemical Co., Ltd.	Inner Mongolia	0.0404	Coal	54.53	/
3	Puyang Pengxin Chemical Co., Ltd.	Henan	0.0656	Coal	85.20	/
4	Anhui Jinhe Industrial Co., Ltd.	Anhui	0.0649	Coal	99.40	/
5	Yunnan Yuntianhua Co., Ltd.	Yunnan	0.0357	Coal	102.95	/
6	Puyang Yongan Chemical Co., Ltd.	Henan	0.0656	Coal	85.20	/
7	Shijiazhuang Shuangyan Chemical Co., Ltd.	Hebei	0.0621	Gas	/	0.20
8	Bazhou Shengfang United Chemical Co., Ltd.	Hebei	0.0621	Coal	85.20	/
9	Shandong Xinzhiyuan Chemical Co., Ltd.	Shandong	0.0554	Gas	/	0.21
10	Ningxia Ningshun New Material Technology Co., Ltd.	Ningxia	0.0645	Coal	78.10	/

Note: 1. Steam of Puyang Pengxin and Ningxia Ningshun is mainly from procurement.

2. Steam coal is calculated as 5,500 kcal.

Source:CCM

3 Production technology of pentaerythritol in China

3.1 Brief introduction and comparison of different production pathways/methods

Technology pathway of pentaerythritol

Based on different condensing agents, the preparation for pentaerythritol can be classified into calcium pathway and sodium pathway.

- Calcium pathway

The condensing agent is calcium hydroxide. The product quality through calcium pathway is good. But the route is long and it tends to form formose, which hinders the yield of pentaerythritol.

At present, no producer uses this pathway to produce pentaerythritol in China. Moreover, relevant patent information during 2019–2023 shows that no new technological breakthrough was made for calcium-based pentaerythritol.

- Sodium pathway

The condensing agent is sodium hydroxide. The route is relatively short. In addition, it is easy to collect and recycle the byproduct sodium formate.

The sodium pathway is widely used around the world. China began to use sodium pathway in 1972. Currently, this pathway is the mainstream production technology in China.

Production method

- High temperature method

The reaction temperature ranges from 40° C to 80° C. The polymerization rate is high in this process and the reaction heat could not be removed in time which results in acceleration of subsidiary reactions and byproducts. This pentaerythritol production method has low yield coefficient and difficulties in the following separation process.

- Low temperature method

The reaction temperature is 25° C–40° C, where the yield of side products is low. This is the most widely used method in the world, and it is also adopted by most producers in China.

Compared with the high temperature method, low temperature sodium pathway has following features:

Advantages:

- High ratio of formaldehyde
- Good product quality
- Surplus formaldehyde can be recycled. The unit consumption of formaldehyde and alkali is low.
- Small consumption of steam
- High reacting concentration
- Large production capacity
- Low pollution to the environment

Disadvantages:

- More equipment
- Long flowchart
- High consumption of formaldehyde requires a large amount of freezing salt solution, which is to say, it requires a large amount of resources.

Both theoretically and practically, this method is favorable for mass production and easy to control the process. It has become the main trend in pentaerythritol production.

Table 3.1-1 Monopentaerythritol technology source of Chinese producers, 2023

No.	Producer	Capacity '23, t/a	Pathway	Technology source
1	Hubei Yihua	70,000	Sodium pathway (Low temperature)	Samyang, South Korea
2	Chifeng Ruiyang	43,000	Sodium pathway (Low temperature)	Domestic technology
3	Puyang Pengxin	20,000	Sodium pathway (Low temperature)	Hubei Yihua
4	Anhui Jinhe	20,000	Sodium pathway (Low temperature)	Domestic technology
5	Yunnan Yuntianhua	11,400	Sodium pathway (Low temperature)	Eurotecnica, Italy
6	Bazhou Shengfang	15,000	Sodium pathway (Low temperature)	Domestic technology
7	Puyang Yongan	10,000	Sodium pathway (Low temperature)	Domestic technology
8	Shijiazhuang Shuangyan	10,000	Sodium pathway (High temperature)	Domestic technology
9	Shandong Xinzhiyuan	30,000	Sodium pathway (High temperature)	Domestic technology
10	Ningxia Ningshun	20,000	Sodium pathway	Domestic technology

Note: Ningxia Ningshun does not disclose its production method.

Source: CCM

Condensation method

- Batch condensation

The reaction takes place in one reactor. Usually in this process, electro dialysis method is employed in the crystallization and centrifugation steps in order to obtain sodium formate. The concentration of pentaerythritol solution must be diluted to less than 14% before electro dialysis in order to avoid the jam of the electro dialysis equipment.

For batch reaction, the final yield of pentaerythritol can reach up to 90%.

Disadvantages:

- Energy cost of the batch condensation process is high.
- The remained formaldehyde in solution can cause film poisoning so that the life of the selection film in the electro dialysis chamber is quite short.

Advantages:

- The purity of both pentaerythritol and sodium formate is good.
- Re-crystallization is not necessary.

- Continuous condensation

At present, many domestic producers have adopted this method. The reaction takes place in a number of continuous reactors. Formaldehyde, acetaldehyde and caustic soda continuously enter the reactors from the bottom and proper quantity of acetaldehyde is supplemented to the reactors.

Advantages:

- High purity pentaerythritol can be gained.
- Different purities of pentaerythritol can be offered from 94% to 99% according to the requirements of clients.
- Energy can be effectively used.
- Larger capacity because of continuous reaction
- Lower energy cost because of proper usage of twice steam

Disadvantages:

- It has a smaller yield compared with batch reaction.
- Because the feedstock enters the reactor from the bottom, there are great changes to mole ratio between formaldehyde and acetaldehyde from bottom to top of the reactor.
- High equipment investment

3.2 Technology problems of pentaerythritol

In recent years, China has made great progress in pentaerythritol production technology. But compared with the overseas market, the Chinese pentaerythritol industry still has many disadvantages:

- Inefficient production technology
- Low-purity products
- Less production specifications
- Severe pollution

There are several pentaerythritol manufacturers and research institutes that have conducted lots of R&D on pentaerythritol production, such as Anhui Jinhe and Chifeng Ruiyang. But there are still some technology bottlenecks in pentaerythritol production:

- In the progress of polymerization, Cannizzaro is an exothermic reaction, which gives out a lot of heat. If the heat is not removed immediately, fast reaction would easily form byproducts, which increases the difficulty in product separation, and influences the conversion rate of the reaction. This is the main reason why the purity of home-made pentaerythritol is low.
- In the de-aldehyde step (distillation), it is difficult to separate methanol from pentaerythritol formed after a long time of condensation.
- In the centrifugal step, it is hard to separate pentaerythritol from sodium formate. The ideal rate of pentaerythritol and sodium formate in the mother solution is 1:4.
- The catalyst in the production is corrosive to facilities, which increases production cost and influences the quality of pentaerythritol.
- It produces lots of organic wastewater, which is highly polluting to the environment.

3.3 Technology achievements of pentaerythritol research

In recent years, many researches related to pentaerythritol have been done in China.

Table 3.3-1 Patents related to pentaerythritol production applied in China, Jan. 2019–April 2024

No.	Patent name	Applicant	Date of application
1	A device for preparing liquid pentaerythritol by separating pentaerythritol mother liquor	Shandong Xinzhiyuan Chemical Co., Ltd.	2022/9/26
2	A column for back-extraction of pentaerythritol mother liquor	Shandong Xinzhiyuan Chemical Co., Ltd.	2022/8/29
3	A method for separating monopentaerythritol and dipentaerythritol	Yunnan Yuntianhua Co., Ltd.	2022/11/26
4	A preparation method of high purity dipentaerythritol	Chongqing Yuntianhua Tianjuxincai Co., Ltd.	2022/8/1
5	A preparation method for co-production of 98% pentaerythritol and 99% pentaerythritol	Anhui Jinhe Industrial Co., Ltd.	2023/11/21
6	A rinsing and purification device for pentaerythritol	Anhui Jinhe Industrial Co., Ltd.	2020/12/21
7	A continuous condensation method of pentaerythritol production	Anhui Jinhe Industrial Co., Ltd.	2020/11/30
8	A comprehensive utilization method of wastewater (from pentaerythritol production) in formaldehyde and acetaldehyde production	Anhui Jinhe Industrial Co., Ltd.	2019/11/19
9	A multiple-effect evaporation method in pentaerythritol production	Anhui Jinhe Industrial Co., Ltd.	2019/11/19
10	A production method of low-energy-consumption 98-grade pentaerythritol	Chifeng Ruiyang Chemical Co., Ltd.	2021/12/31

11	A separation method for pentaerythritol through crystallization	Chifeng Ruiyang Chemical Co., Ltd.	2021/12/2
12	A production method of tripentaerythritol with a purity greater than 90%	Chifeng Ruiyang Chemical Co., Ltd.	2020/9/9
13	A production method of 95% dipentaerythritol	Chifeng Ruiyang Chemical Co., Ltd.	2020/9/4
14	A crystallization device for pentaerythritol production	Chifeng Ruiyang Chemical Co., Ltd.	2020/9/2
15	A method and device for continuous condensation of mono-, di- and tripentaerythritol	Chifeng Ruiyang Chemical Co., Ltd.	2020/3/31
16	A purification method and device for by-product crude sodium formate from pentaerythritol production	Chifeng Ruiyang Chemical Co., Ltd.	2019/12/24
17	A sampling mechanism used for sampling during pentaerythritol production	Chifeng Ruiyang Chemical Co., Ltd.	2019/8/14
18	A gas-liquid separator for treating tail gas produced from pentaerythritol production	Chifeng Ruiyang Chemical Co., Ltd.	2019/8/6
19	A transfer and dust removal mechanism for corn crushing process of pentaerythritol production	Chifeng Ruiyang Chemical Co., Ltd.	2019/8/6
20	A preparation method of monopentaerythritol and dipentaerythritol	Jiangsu Hankai Engineering Technology Co., Ltd.	2019/4/30
21	An improved synthesis method of pentaerythritol with low aldehyde ratio	Hubei Yihua Chemical Industry Co., Ltd.	2023/9/12
22	A method for processing pentaerythritol mother liquor	Inner Mongolia Yihua Chemical Co., Ltd.	2021/6/7
23	A pentaerythritol mother liquor extraction tower	Puyang Pengxin Chemical Co., Ltd.	2023/2/8
24	A production method for further purification of tripentaerythritol	Puyang Yongan Chemical Co., Ltd.	2019/3/27
25	A system and method for separating pentaerythritol and calcium formate from pentaerythritol mother liquor	Wuxi Rongfeng Biological Engineering Co., Ltd.	2022/2/18
26	An extraction column of pentaerythritol mother liquor	Wuxi Rongfeng Biological Engineering Co., Ltd.	2021/7/26
27	A process for separating pentaerythritol byproduct sodium formate through membrane	Zhejiang Lanbo New Material Technology Co., Ltd.	2021/7/15

Source:CCM

4 Industry analysis in China

4.1 SWOT analysis

Table 4.1-1 SWOT analysis of Hubei Yihua's development in 2023

	Strength	Weakness
Hubei Yihua	<ol style="list-style-type: none"> 1. Top pentaerythritol producer in China 2. As a listed company, Hubei Yihua enjoys mature financing channels. 3. Advanced equipment and technology from Samyang Chemical Industries Co., Ltd. 4. Self-sufficiency of formaldehyde, acetaldehyde and energy 	<ol style="list-style-type: none"> 1. Insufficient supervision on pentaerythritol production work safety. 2. Waste water treatment
Opportunity	SO	WO
Some pentaerythritol manufacturers have stopped production because of environmental issues and low profits.	<ol style="list-style-type: none"> 1. Improve product quality so as to take up more domestic market shares of high-end products. 2. Expand its international presence. 	Upgrade current production equipment and improve environmental protection technologies.
Threat	ST	WT
<ol style="list-style-type: none"> 1. As a large-scale manufacturer of minerals and chemicals, Hubei Yihua is troubled by slow industrial transformation and upgrading. 2. Pentaerythritol producers suffer increasingly stringent requirements for waste disposal and work safety. 	Shift from low-grade monopentaerythritol to high-grade ones and dipentaerythritol to take up larger shares in domestic market.	Increase investment in environmental protection facilities.

Source:CCM

Table 4.1-2 SWOT analysis of Chifeng Ruiyang's development in 2023

	Strength	Weakness
Chifeng Ruiyang	<ol style="list-style-type: none"> 1. Leading pentaerythritol producer in China 2. Broad product portfolio: monopentaerythritol (95%, 98% and 99%), dipentaerythritol (85% and 90%) and tripentaerythritol 	<ol style="list-style-type: none"> 1. Waste water treatment 2. Chifeng Ruiyang still cannot rival its overseas counterparts in product quality.
Opportunity	SO	WO
Demand for dipentaerythritol and tripentaerythritol has risen steadily.	<ol style="list-style-type: none"> 1. Expand in domestic dipentaerythritol and tripentaerythritol markets. 2. Improve the quality of dipentaerythritol and tripentaerythritol and expand its presence in overseas markets. 	Enlarge the production capacity of high-purity monopentaerythritol, dipentaerythritol and tripentaerythritol in the future.
Threat	ST	WT
<ol style="list-style-type: none"> 1. Intense competition in domestic and overseas pentaerythritol markets. 2. More stringent environmental policies in China 	Increase investment into waste disposal facilities in the face of huge environmental protection pressures.	Increase investment in environmental protection facilities and the R&D of products.

Source:CCM

Table 4.1-3 SWOT analysis of Yunnan Yuntianhua's development in 2023

	Strength	Weakness
Yunnan Yuntianhua	1. Advanced technology and equipment from Eurotecnica in Italy, and high product quality. 2. As a listed company, Yunnan Yuntianhua enjoys diversified financing channels and is well-capitalized.	Relatively small capacity limits its share in the pentaerythritol market.
Opportunity	SO	WO
Domestic demand for high-grade monopentaerythritol, dipentaerythritol and tripentaerythritol has increased quickly.	Expand in the domestic high-end pentaerythritol market based on its low operating costs and high product quality.	Expand the production of monopentaerythritol and dipentaerythritol, and develop tripentaerythritol production capacity.
Threat	ST	WT
1. Intense competition in the pentaerythritol market. 2. More stringent environmental protection policies in China	Increase investment into waste disposal facilities due to huge environmental protection pressures.	Create brand awareness to enlarge market share.

Source:CCM

Table 4.1-4 SWOT analysis of Shandong Xinzhiyuan's development in 2023

	Strength	Weakness
Shandong Xinzhiyuan	It has the largest single-line production capacity, reaching 30,000 t/a.	As a new entrant, it lacks market recognition.
Opportunity	SO	WO
Domestic demand for high-grade pentaerythritol has increased quickly.	1. Increase R&D investment to improve high quality pentaerythritol. 2. Expand in overseas market.	1. Create brand awareness to enlarge market shares. 2. Accelerate independent R&D on downstream products.
Threat	ST	WT
Intense competition in the pentaerythritol market.	Increase capacity for high-purity products to gain more market share.	Increase investment in the R&D of products.

Source:CCM

4.2 Competitiveness analysis of Chinese pentaerythritol industry

- Sufficient raw material supply

China's sufficient feedstock supply is conducive to its pentaerythritol production. China's output of methanol, the most important raw material for pentaerythritol, kept growing in the past five years, reaching 83,173,000 tonnes in 2023; the product quality has also improved. Abundant supply of methanol, as well as formaldehyde, provides solid foundation for the production of pentaerythritol.

Some domestic large-scale formaldehyde and pentaerythritol manufacturers, such as Hubei Yihua, Yunnan Yuntianhua and Anhui Jinhe, self-produce methanol, which helps save production cost significantly and therefore increases profits. These producers have already benefited from integrated industrial chains and largely extended their industrial scales.

- High quality

China's pentaerythritol quality has kept improving in recent years and the gap between domestic and overseas products has narrowed. This should be attributed to technology advancement of leading domestic manufacturers. Hubei Yihua introduced proprietary production method of monopentaerythritol and dipentaerythritol from Samyang Chemical Industries Co., Ltd. in 2002 so as to produce pentaerythritol of world leading quality (hydroxyl content: 98%). Yunnan Yuntianhua imported a full set of pentaerythritol production lines from Eurotecnica, and it is able to manufacture pentaerythritol of diversified purities (96%–99%) with stable quality. Technological upgrading of leading enterprises has significantly pushed up product quality of the whole industry.

In this context, mainstream pentaerythritol producers switch to the production of high-purity, high-quality pentaerythritol products to satisfy constantly growing international demands. For instance, Yunnan Yuntianhua stopped the production of 93% pentaerythritol in 2021 and turned to producing more 98% pentaerythritol, 99% pentaerythritol and dipentaerythritol to meet market demand. That is to say, domestic manufacturers' pentaerythritol product portfolios have undergone adjustment.

- Low price

Low price used to be one of the important features of China's chemical industry. China's pentaerythritol products maintain relatively low prices in spite of improved quality because the price of formaldehyde is much lower than that in developed countries. Moreover, China's labor resources are still sufficient and cheaper, leading to lower operating costs in domestic pentaerythritol manufacturers.

5 Import and export analysis

5.1 Anti-dumping duty on pentaerythritol

- India

On 4 Feb., 2005, the Ministry of Commerce and Industry of India launched an anti-dumping investigation against the imports of pentaerythritol originating in or exported from China and Sweden.

On 2 Feb., 2006, the Ministry of Commerce and Industry of India published the final affirmative determination on concerning imports of pentaerythritol originating in or exported from China and Sweden.

On 20 April, 2006, the Ministry of Finance (MOF) of India announced the imposition of an anti-dumping duty on pentaerythritol from China and Sweden.

On 26 March, 2010, the Ministry of Commerce and Industry of India initiated the first anti-dumping sunset review investigation on concerning imports of pentaerythritol from China and Sweden.

On 25 March, 2011, the Ministry of Commerce and Industry of India decided to continue anti-dumping duty against products from China, while revoke the anti-dumping duty on Swedish ones.

On 14 June, 2011, the MOF of India announced the prolongation of anti-dumping duty against pentaerythritol from China for the first time.

On 7 June, 2016, the Ministry of Commerce and Industry of India initiated the second sunset review of anti-dumping investigations concerning imports of pentaerythritol originating in or exported from China at the request of Kanoria Chemicals & Industries Limited. The period of investigation (POI) for the purpose of the review was April 2015 to March 2016 (12 months). The examination in the context of injury analysis covered the periods April 2012–March 2013, April 2013–March 2014, April 2014–March 2015 and the POI.

On 12 May, 2017, the Ministry of Commerce and Industry of India delivered the final determination on the second sunset review of anti-dumping campaign against pentaerythritol from China, deciding to collect an anti-dumping duty of USD185.15/t on involved products, which would be implemented since issuance.

On 12 May, 2023, the Ministry of Commerce and Industry of India initiated anti-dumping investigations against pentaerythritol originating in or exported from the Chinese mainland, Saudi Arabia and Taiwan Province of China, in response to a petition filed by the Indian company Kanoria Chemicals & Industries Limited. The POI was from July 2022 to March 2023 (9 months), and the injury analysis period was from 2019 to 2020, 2020 to 2021, April 2021 to June 2022, and the POI.

On 20 Feb., 2024, the Ministry of Commerce and Industry of India announced that it would make a final affirmative anti-dumping determination on pentaerythritol originating in or imported from Chinese Mainland, Saudi Arabia and Taiwan, and proposed to impose anti-dumping duties on the products involved in the above countries and regions for a period of five years, namely, USD345.15/t in Chinese Mainland, USD300.15/t in Saudi Arabia and USD499.01/t in Taiwan.

- Turkiye

In Feb. 2005, Turkiye launched an investigation of anti-dumping measure on pentaerythritol from China. On 28 July, 2005, it decided to impose an anti-dumping duty of USD270/t on all imports of pentaerythritol from China.

On 23 July, 2010, Turkiye launched the sunset review investigation of anti-dumping measure on pentaerythritol from China. On 3 May, 2011, it decided that the duty of USD270/t on pentaerythritol from China would be imposed for another five years.

On 14 May, 2017, Turkiye delivered the final determination on the sunset review of anti-dumping campaign against pentaerythritol from China, deciding to keep collecting an anti-dumping duty of USD270/t on involved products.

- The European Union

On 17 Jan., 2006, the European Commission published a notice of initiation of an anti-dumping proceeding concerning pentaerythritol originated from the US, China, Russia, Turkiye and Ukraine. But the anti-dumping investigation into pentaerythritol originated from the five countries was terminated on 5 April, 2007.

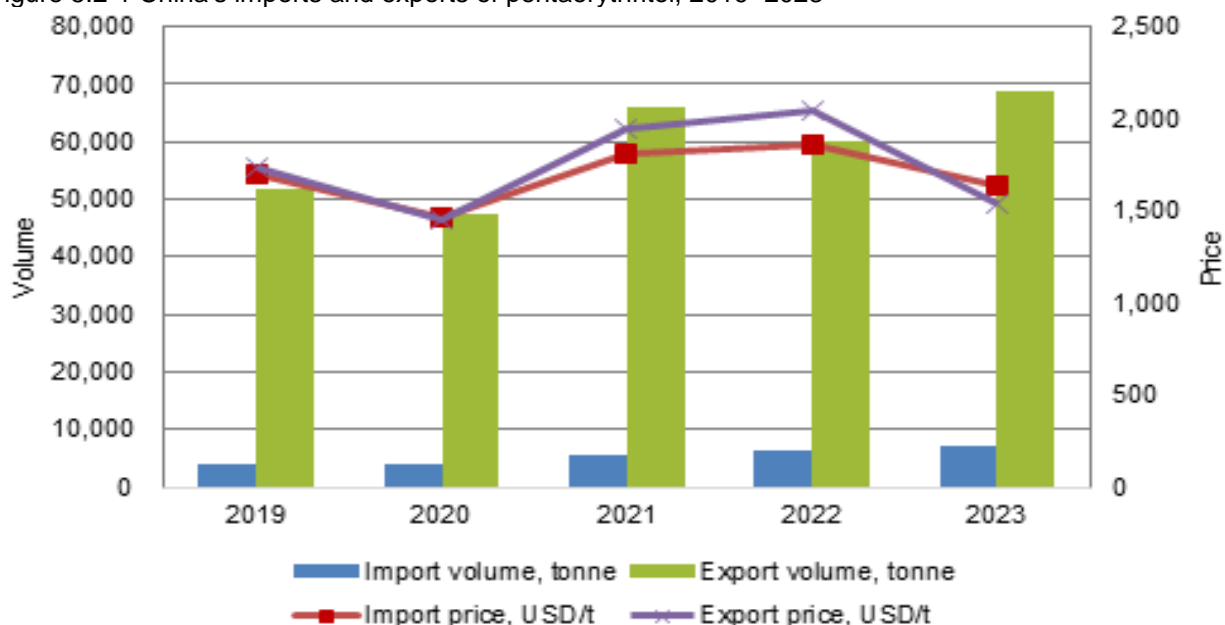
5.2 Import and export of pentaerythritol, 2023

China is a net exporter of pentaerythritol. In 2019, the annual export of pentaerythritol remained above 50,000 tonnes. But the export volume dropped by some 8.4% year on year in 2020, due to sluggish overseas demand influenced by COVID-19. However, it surged to 65,932 tonnes in 2021 with recovered overseas demand. In 2022, the export volume dropped to nearly 60,000 tonnes because of decreased overseas demand. In 2023, China's export volume of pentaerythritol reached a new high of 68,934 tonnes due to the deregulation of COVID-19 and the increase in new export orders.

In 2019 and 2020, the annual import volume of pentaerythritol in China hovered around 3,900 tonnes. Since 2021, the import volume of pentaerythritol has started to increase rapidly. From 2021 to 2023, the import volume increased from 5,543 tonnes to 7,157 tonnes, with a CAGR of 13.6%.

In 2022, China's pentaerythritol import price and export price averaged at USD1,861/t and USD2,051/t, with a yearly increase of 2.9% and 5.1%, respectively. However, in 2023, both the import and export prices of pentaerythritol in China significantly declined—the import price decreased by 12.0% year on year to USD1,638/t, while the export price decreased by 25.0% year on year to USD1,538/t.

Figure 5.2-1 China's imports and exports of pentaerythritol, 2019–2023



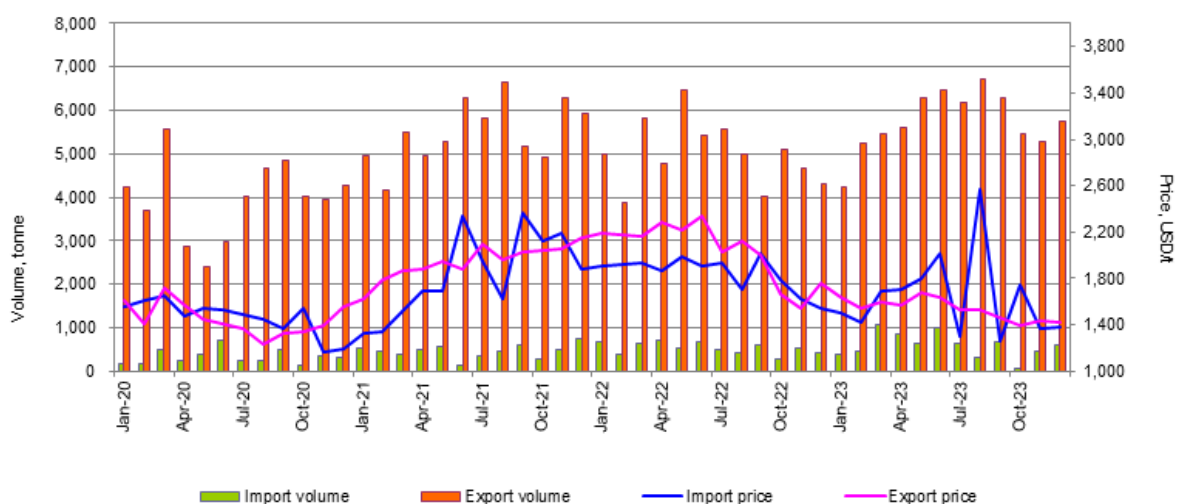
Source: China Customs & CCM

Table 5.2-1 China's imports and exports of pentaerythritol, 2019–2023

Year	Import			Export		
	Volume, tonne	Value, USD	Price, USD/t	Volume, tonne	Value, USD	Price, USD/t
2019	3,947	6,728,863	1,705	51,922	89,978,940	1,733
2020	3,896	5,704,339	1,464	47,538	69,037,148	1,452
2021	5,543	10,030,031	1,809	65,932	128,638,120	1,951
2022	6,373	11,861,233	1,861	60,001	123,071,127	2,051
2023	7,157	11,720,438	1,638	68,934	105,999,853	1,538

Source: China Customs & CCM

Figure 5.2-2 China's imports and exports of pentaerythritol by month, Jan. 2020–Dec. 2023



Source: China Customs & CCM

Table 5.2-2 China's import and export volume of monopentaerythritol, dipentaerythritol and tripentaerythritol, 2023, tonne

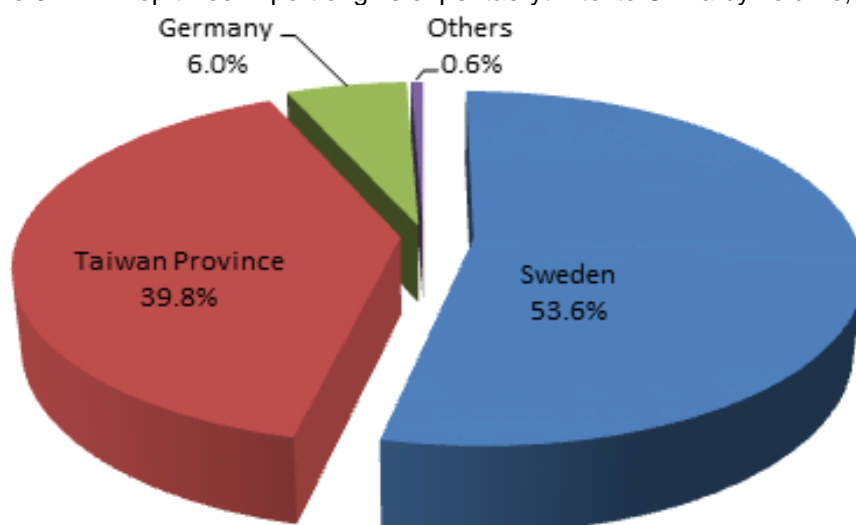
Item	Monopentaerythritol	Dipentaerythritol	Tripentaerythritol
Export volume	64,840	3,915	179
Import volume	7,095	59	3

Source: China Customs & CCM

5.2.1 Analysis on import

Sweden, Taiwan Province and Germany were the three largest import origins of pentaerythritol to China by volume, together accounting for 99.4% of the total import volume in 2023. Specifically, China's imported pentaerythritol from Taiwan Province and Germany increased by 55.7% and 39.9% year on year, respectively, while that from Sweden decreased by 4.9% year on year. At the same time, the average import prices in Sweden and Taiwan decreased by 8.7% and 24.5% year on year, respectively, while the average import price in Germany remained basically the same as in 2022.

Figure 5.2.1-1 Top three import origins of pentaerythritol to China by volume, 2023



Source: China Customs & CCM

Table 5.2.1-1 China's imports of pentaerythritol by origin, 2023

No.	Origin	Import volume, tonne	Import value, USD	Import price, USD/t
1	Sweden	3,837	6,072,998	1,583
2	Taiwan Province	2,849	4,116,400	1,445
3	Germany	428	1,430,190	3,342
	Others	44	100,850	2,305
	Total	7,157	11,720,438	1,638

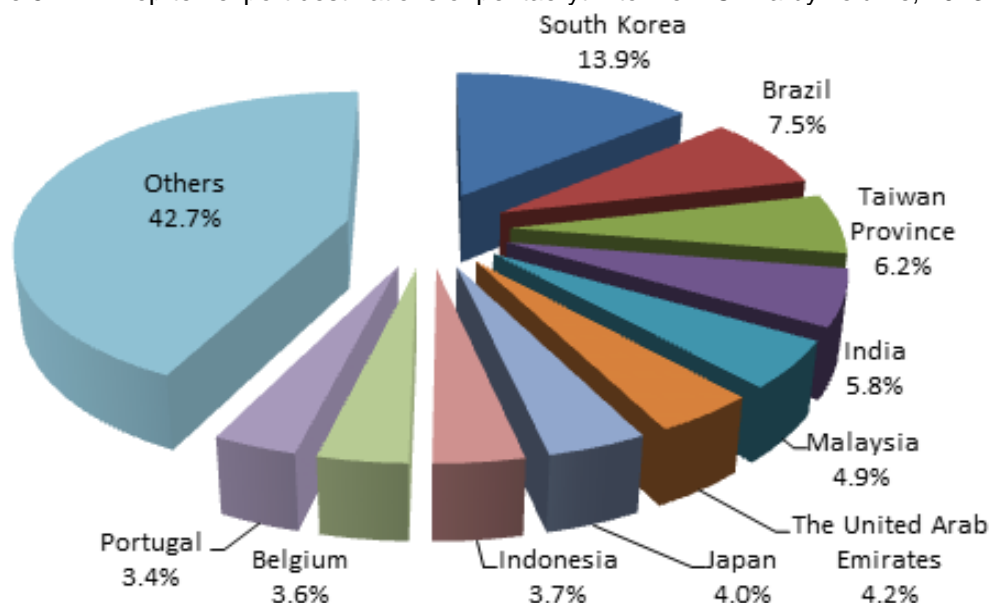
Source: China Customs & CCM

5.2.2 Analysis on export

China mainly exports pentaerythritol to Asia Pacific, followed by Europe and South America. In 2023, South Korea remained the largest export destination of China's pentaerythritol by volume, accounting for 13.9% of the total export volume, followed by Brazil, Taiwan Province, India and Malaysia.

It is worth noting that in 2023, China exported 2,358 tonnes of pentaerythritol to Portugal, an increase of 2,130 tonnes compared to 2022 and a year-on-year surge of 934.2%. Moreover, the volume exported to South Korea, India, Belgium, and Italy also saw notable upticks by 1,453 tonnes, 1,327 tonnes, 1,043 tonnes, and 1,275 tonnes, respectively, with year-on-year growth of 17.9%, 49.2%, 71.3%, and 300.3%. Conversely, the volume exported to Singapore shrank, with a year-on-year decrease of 53.1% to 972 tonnes.

Figure 5.2.2-1 Top ten export destinations of pentaerythritol from China by volume, 2023



Source: China Customs & CCM

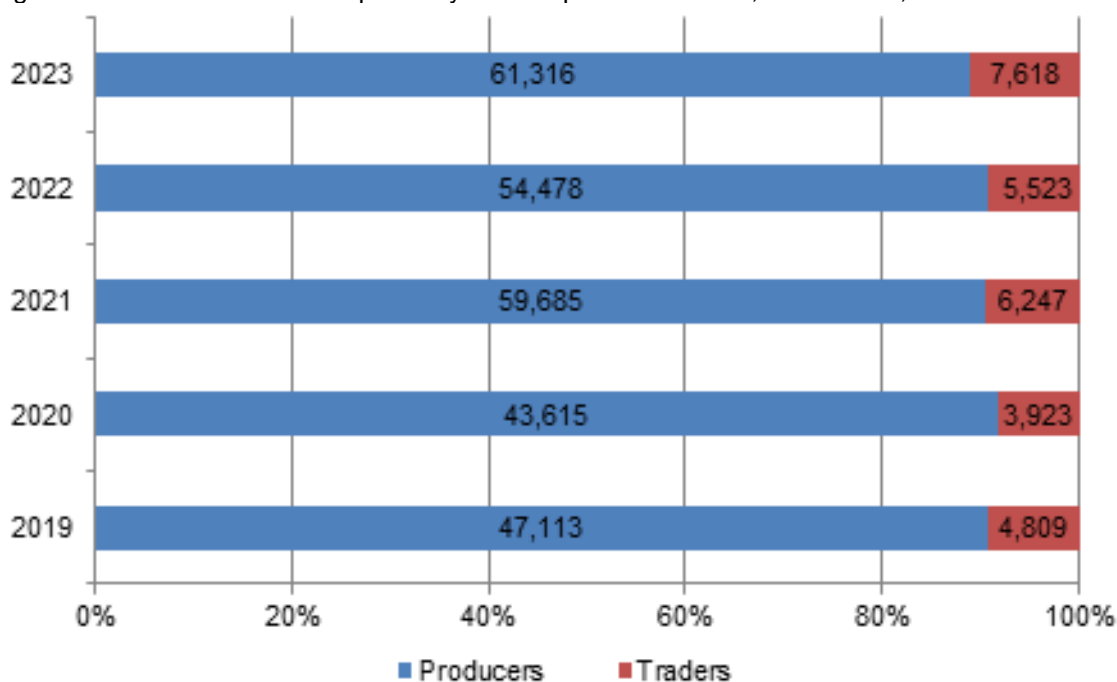
Table 5.2.2-1 China's exports of pentaerythritol by destination, 2023

No.	Destination	Export volume, tonne	Export value, USD	Export price, USD/t
1	South Korea	9,573	15,584,004	1,628
2	Brazil	5,189	7,117,935	1,372
3	Taiwan Province	4,262	9,293,302	2,180
4	India	4,021	4,953,430	1,232
5	Malaysia	3,357	4,745,291	1,413
6	The United Arab Emirates	2,902	3,645,279	1,256
7	Japan	2,781	6,947,034	2,498
8	Indonesia	2,536	3,190,244	1,258
9	Belgium	2,506	4,185,377	1,670
10	Portugal	2,358	2,963,239	1,257
	Others	29,450	43,374,718	1,473
	Total	68,934	105,999,853	1,538

Source: China Customs & CCM

The volume of pentaerythritol directly exported by producers has remained over 43,000 tonnes in 2019–2023, and about 60.5% of exported pentaerythritol in 2023 was produced by Hubei Yihua and Chifeng Ruiyang, the top two producers in China.

Figure 5.2.2-2 Classification of pentaerythritol exporters in China, 2019–2023, tonne



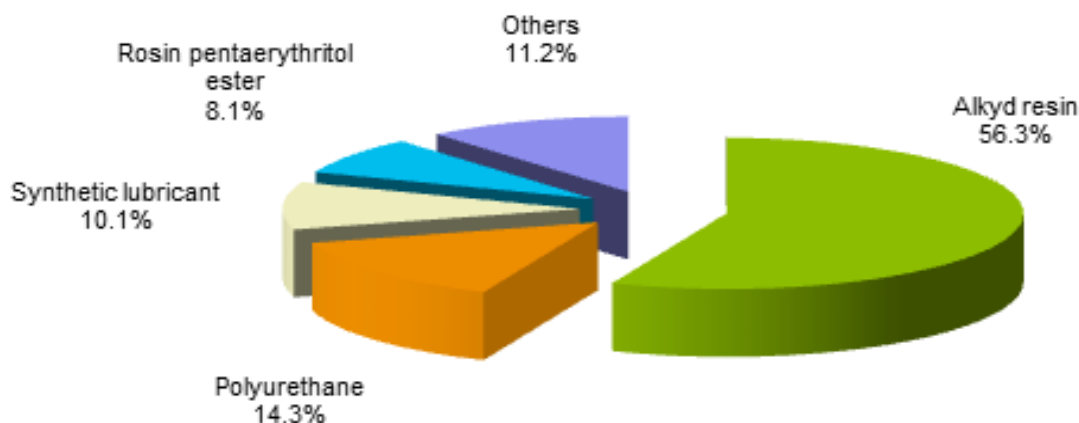
Source: China Customs & CCM

6 Consumption of pentaerythritol in China

6.1 Consumption pattern

As an important raw material and intermediate for fine chemicals, pentaerythritol is mainly consumed in the production of alkyd resin, polyurethane (PU), synthetic lubricant, rosin pentaerythritol ester, etc. in China.

Figure 6.1-1 Apparent consumption of pentaerythritol in China by end use segment, 2023



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

Dipentaerythritol is mainly consumed in the production of dipentaerythritol hexaacrylate (DPHA) and dipentaerythritol ester in China. DPHA is mainly used in ultraviolet curing coating, which can increase the hardness and reaction degree of crosslinking. Dipentaerythritol ester is widely used in synthetic polymeric compound, lubricant oil, paint, printing ink, surfactant, etc.

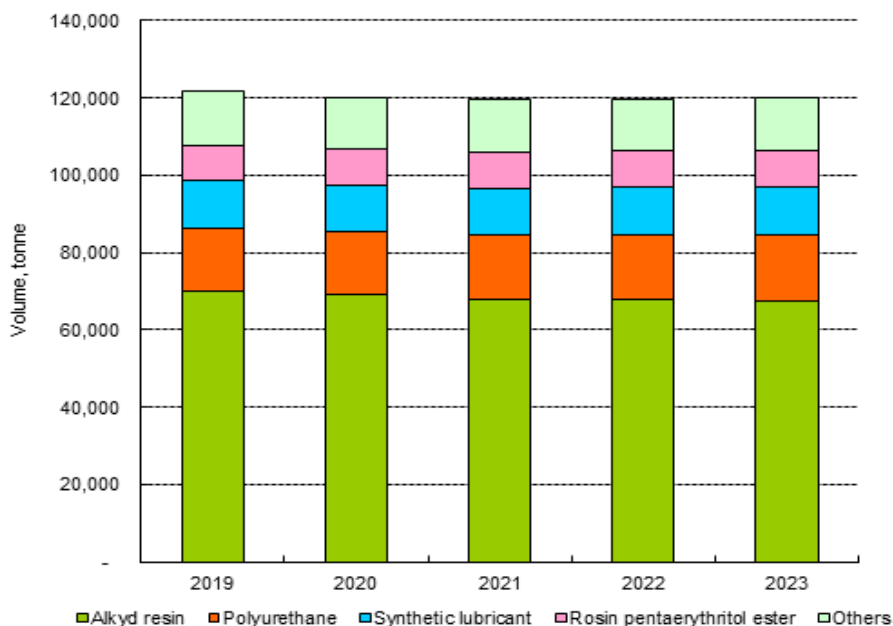
Tripentaerythritol is used to produce tripentaerythritol octaacrylate, tripentaerythritol hexastearate and tripentaerythritol phosphate flame retardant, etc.

6.2 Consumption in major end-use segments

The consumption of pentaerythritol continued to decline in 2019–2021, during which the market was relatively weak, especially in 2020–2021 when the COVID-19 affected on a large scale. In 2021–2023, the consumption of pentaerythritol stayed below 120,000 tonnes, as the recovery of market demand was slow.

To be specific, consumption of pentaerythritol saw continuous decreases in alkyd resin sector but increases in PU and rosin pentaerythritol ester sectors in 2019–2023, while the volumes in synthetic lubricant and other fields fluctuated overall. As synthetic lubricant, rosin pentaerythritol ester and PU have higher quality requirements for pentaerythritol, domestic pentaerythritol has been gradually developing towards higher-end of the spectrum.

Figure 6.2-1 Apparent consumption of pentaerythritol in China by end-use segment, 2019–2023



Source:CCM

6.3 Brief introduction to each major end use segment

6.3.1 Alkyd resin

In China, a large number of pentaerythritol is used in the production of alkyd resin coatings and the applications in bridges, vehicles, ships and aircraft coating continuously support the demand for pentaerythritol.

Alkyd resin is prepared by polycondensation reaction with polyhydric alcohol, organic acid and fatty acid as main raw materials. The polyhydric alcohols commonly used in the production of alkyd resin include glycerol, pentaerythritol, propylene glycol, etc. Thereinto, pentaerythritol has the advantages of good quick drying, high hardness, and high gloss, and has been widely used in industrial production.

China's pentaerythritol consumption in alkyd resin kept decreasing, at a CAGR of -1.0% in 2019–2023, because of the decreasing domestic demand for alkyd resin, which has faced strong competition from acrylic resin. The consumption volume of pentaerythritol in alkyd resin decreased to 67,500 tonnes in 2023, affected by increasing substitution.

Figure 6.3.1-1 Pentaerythritol consumption volume in alkyd resin in China, 2019–2023



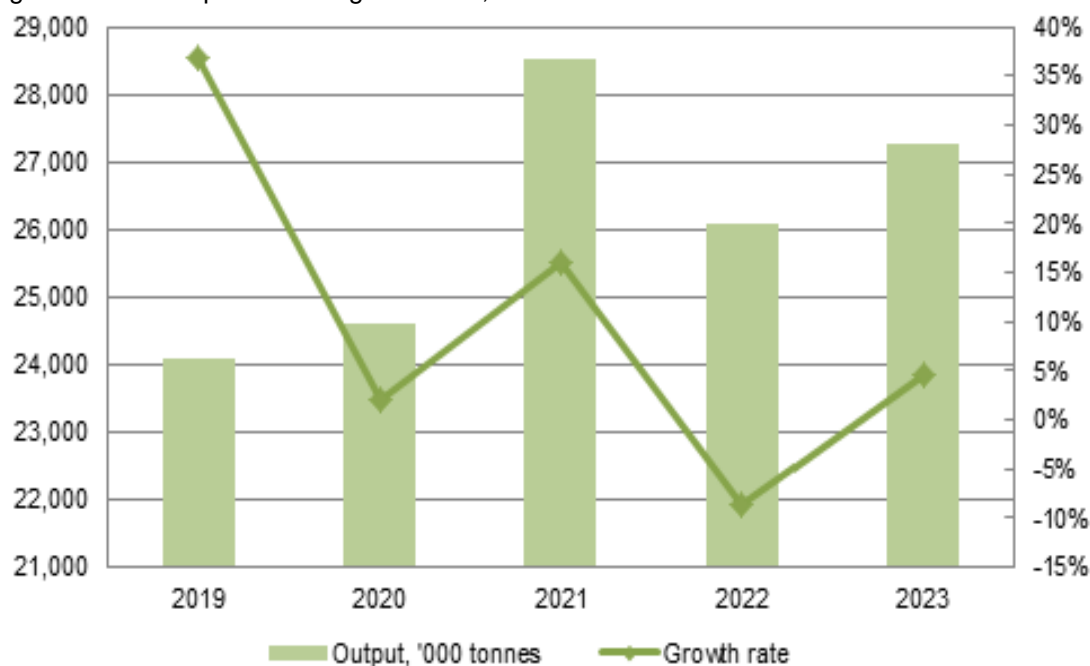
Source:CCM

From 2019 to 2021, China's coating output continued to grow, with a CAGR of 8.8%. However, the output in 2022 decreased, mainly due to a decrease in demand for building coatings. In 2023, the output rebounded, with a year-on-year increase of 4.5%.

In 2023, China's automobile output and sales volume exceeded 30.0 million units for the first time, with a significant year-on-year increase of 11.6% and 12.0%, respectively. The growth in the production and sales of automobile spurred an increase in the output and sales of automobile coatings. Moreover, ship coatings also saw a significant year-on-year growth as driven by expanded ship orders. However, construction coatings faced a slow recovery due to the downturn in the real estate market.

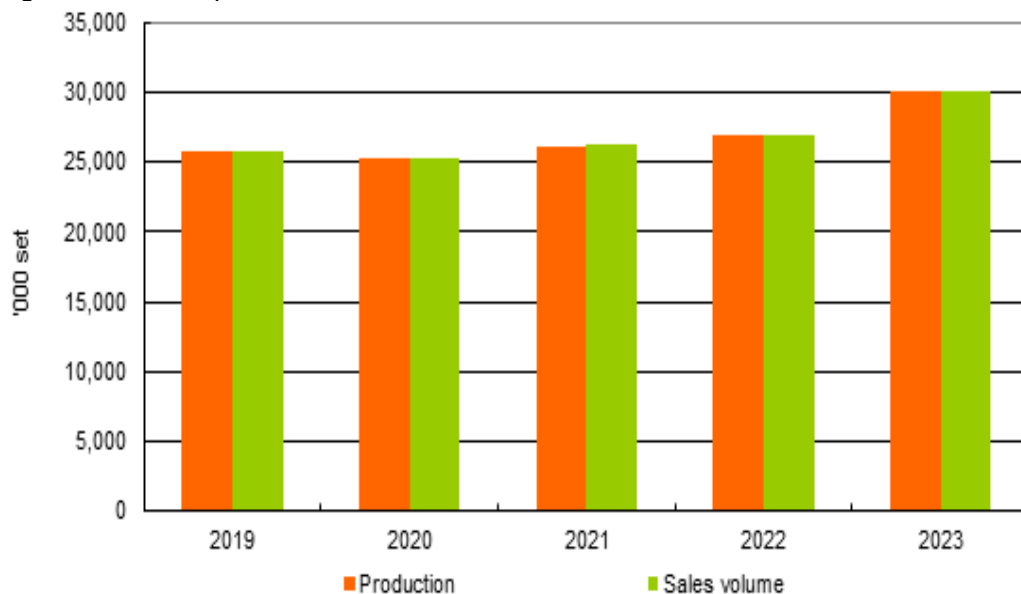
Overall, in 2023, the consumption of the coating market rebounded. Despite this, the domestic consumption of alkyd resin coatings was declining due to the impact of substitutes. Accordingly, the consumption of pentaerythritol in alkyd resins slightly decreased.

Figure 6.3.1-2 Output of coatings in China, 2019–2023



Source: National Bureau of Statistics & China Coating Industry Association

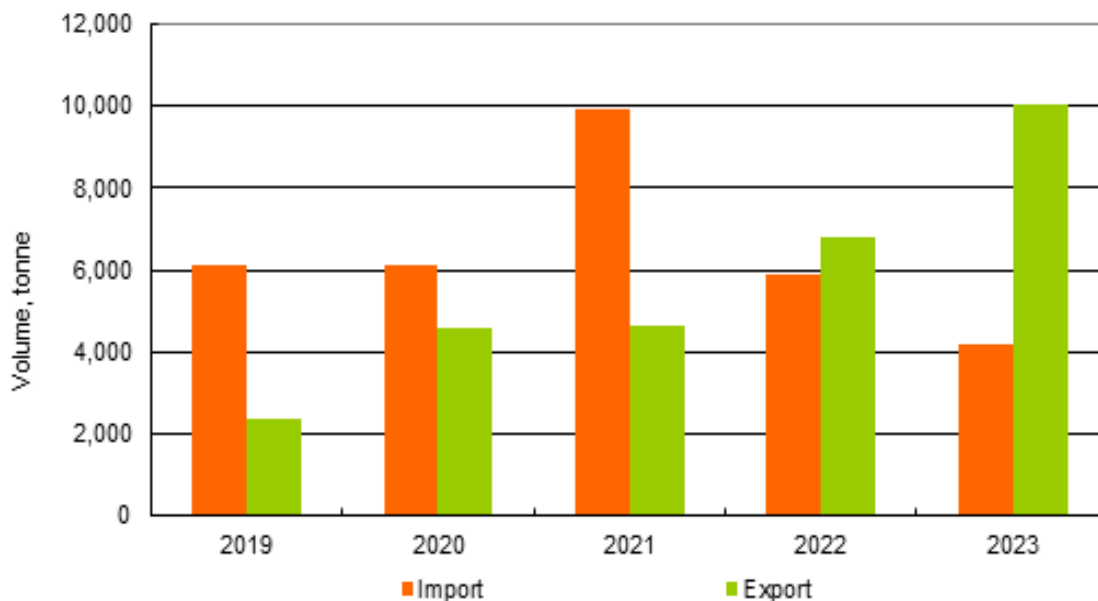
Figure 6.3.1-3 Output and sales volume of automobile in China, 2019–2023



Source: China Association of Automobile Manufacturers

The import volume of China's alkyd resin showed a downward trend in recent years, while the export volume continued to rise. In 2023, the import volume of alkyd resin in China reached its decade low of 4,162 tonnes. And to the contrary, the export volume reached its highest point in nearly a decade, at 10,048 tonnes.

Figure 6.3.1-4 China's import & export of alkyd resin (HS Code: 39075000), 2019–2023



Source: China Customs

Alkyd resin is the largest end use segment of pentaerythritol in China, yet the alkyd resin made from pentaerythritol accounts for a small proportion of the total. And with heavy competition from acrylic resin, demand for pentaerythritol from this sector will slowly decrease.

6.3.2 Polyurethane

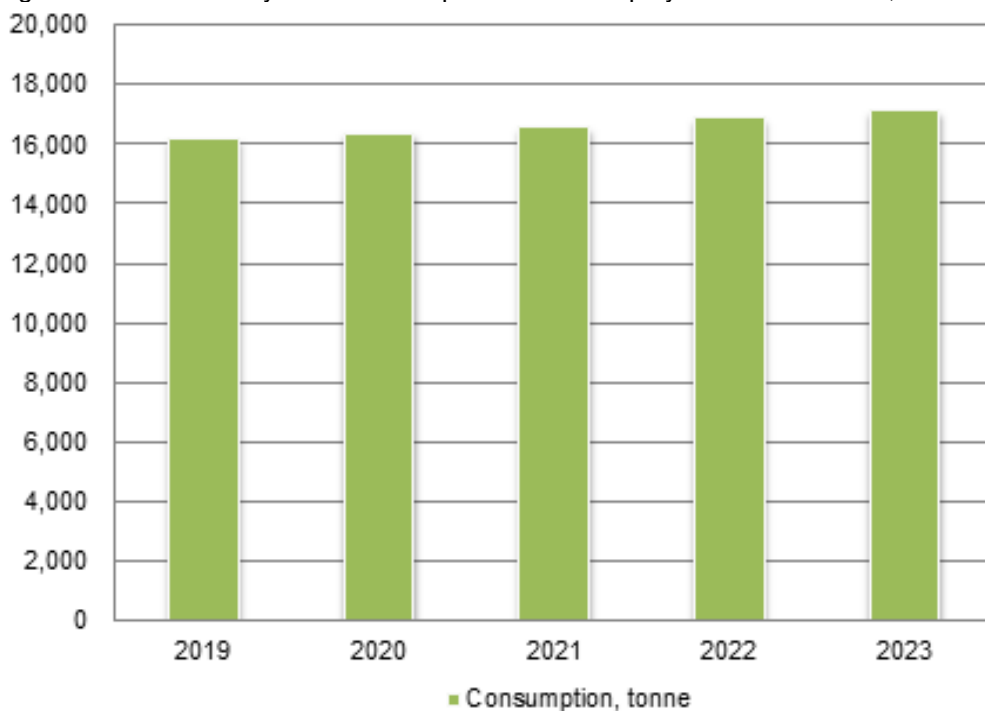
In polyurethane (PU) production, pentaerythritol is used to make polyester polyols and polyether polyols, the latter of which are one of the main raw materials for polyurethane foam materials.

As a substitute for glycerol, pentaerythritol is used to produce PU materials. In recent years, the Chinese PU industry developed rapidly. At the same time, glycerol market has been in short supply, even though glycerol output has risen in general. In addition, from the production process point of view, it is easier to produce polyurethane from pentaerythritol than glycerol. As a result, many PU manufacturers have adopted pentaerythritol to replace glycerol.

In the past, glycerol was widely used in the preparation of rigid PU or semi-rigid PU, as it has three functional groups of hydroxyl, which are easy to form three-dimensional network embodying the hardness property to the PU products. As pentaerythritol has four hydroxyl groups, it is more suitable for the preparation of rigid PU or semi-rigid PU, compared with polyether triols like glycerol. So pentaerythritol has been widely used to replace glycerol to produce polyester polyols and polyether polyols.

In the past five years, the consumption volume of pentaerythritol in PU production has steadily increased at a CAGR of 1.4%. In 2023, due to the release of new capacity in the PU field, the consumption of pentaerythritol in this field increased by 1.5% year on year, reaching 17,150 tonnes.

Figure 6.3.2-1 Pentaerythritol consumption volume in polyurethane in China, 2019–2023



Source:CCM

PU can be used in energy-saving materials. The consumption volume of pentaerythritol in the PU industry will keep a stable growth in the next few years.

On the one hand, PU will maintain stable growth in traditional industries, such as automobile, household appliances and textile. Taking automobiles as an example, with further implementation of the national energy-saving and emission reduction policies, increasing demand for energy-saving materials in automobiles will ensure the continuous growth of the demand for PU foam.

On the other hand, building energy conservation, new energy, high-speed rails, pipeline transportation, medical treatment and other fields will be new development trends for PU industry. Taking the construction industry as an example, with implementation of relevant laws and regulations on building energy conservation in China, the application of rigid PU foam will be widened, which also gives an opportunity for the popularization of PU.

6.3.3 Lubricant (high-grade)

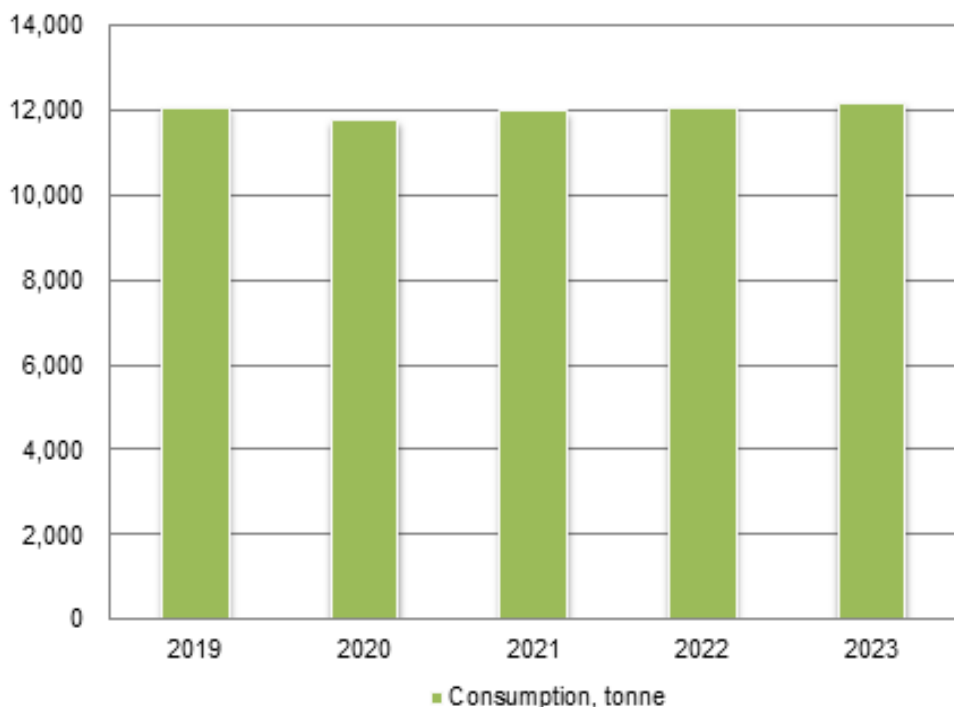
Usually in lubricant field, high-purity monopentaerythritol (98% at minimum) or dipentaerythritol is required to react with C5–10 aliphatic acids to generate aliphatic esters. Aliphatic esters can be used as the base oil in high-grade lubricants for excellent high- and low-temperature properties, high flash point and low pour point.

High-grade lubricant is widely used in the aviation field, mainly applied in aeroengines and chains under high-temperature working conditions. It is also used in other fields such as automobile engines.

As the economy improved in 2016, domestic consumption volume of pentaerythritol in this sector jumped above 10,000 tonnes. In 2017, the National Standards for Pollutants Discharge by Motor Vehicles (Phase V) was implemented. Therefore, quality of lubricant needed to be improved and the demand for high-grade lubricant for vehicles increased. The consumption of pentaerythritol was above 12,000 tonnes from 2017 to 2019.

In 2020, demand for high-grade lubricant weakened slightly because of the ravaging COVID-19; the consumption of pentaerythritol in high-grade lubricant reduced to 11,800 tonnes. Boosted by recovering economy and rising demand from domestic high-grade lubricant market, 2021 and 2022 witnessed slight increases in pentaerythritol consumption in this sector. In 2023, with the recovery of the aviation manufacturing industry, the consumption of high-grade lubricants continued to grow, driving the consumption growth of pentaerythritol in this field.

Figure 6.3.3-1 Pentaerythritol consumption volume in high-grade lubricant in China, 2019–2023



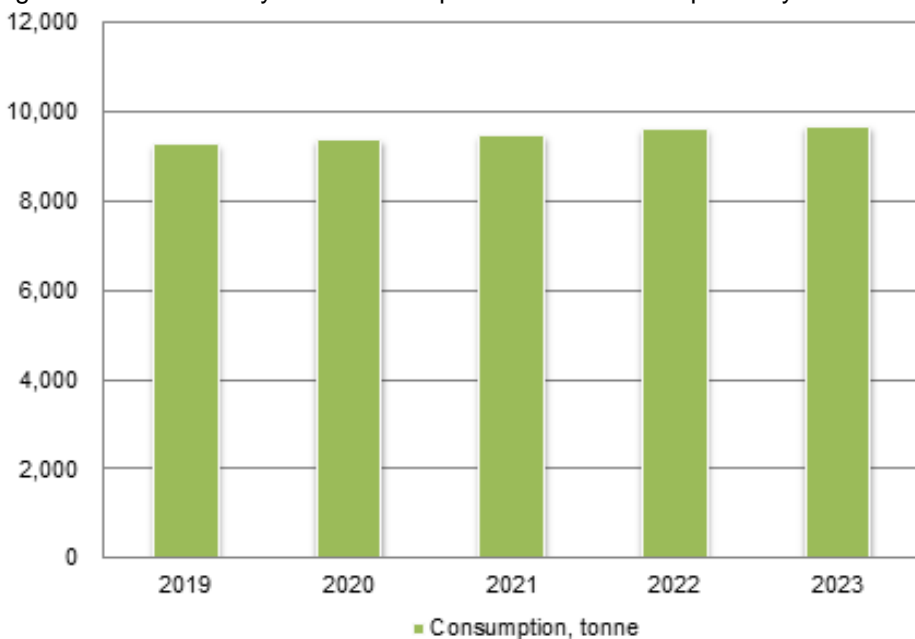
Source:CCM

6.3.4 Rosin pentaerythritol ester

In China, rosin pentaerythritol ester is reported as a high-grade product to be widely used in coatings, papermaking, adhesives, rubber assistants and ink (tall oil). These sectors are developing, which require many higher-grade products (like rosin pentaerythritol ester) to replace the current low-grade products.

In 2019, affected by COVID-19, consumption volume of pentaerythritol in rosin pentaerythritol ester significantly decreased, but slowly recovered in 2020–2023. In 2023, the consumption of pentaerythritol in rosin pentaerythritol ester reached 9,700 tonnes.

Figure 6.3.4-1 Pentaerythritol consumption volume in rosin pentaerythritol ester in China, 2019–2023



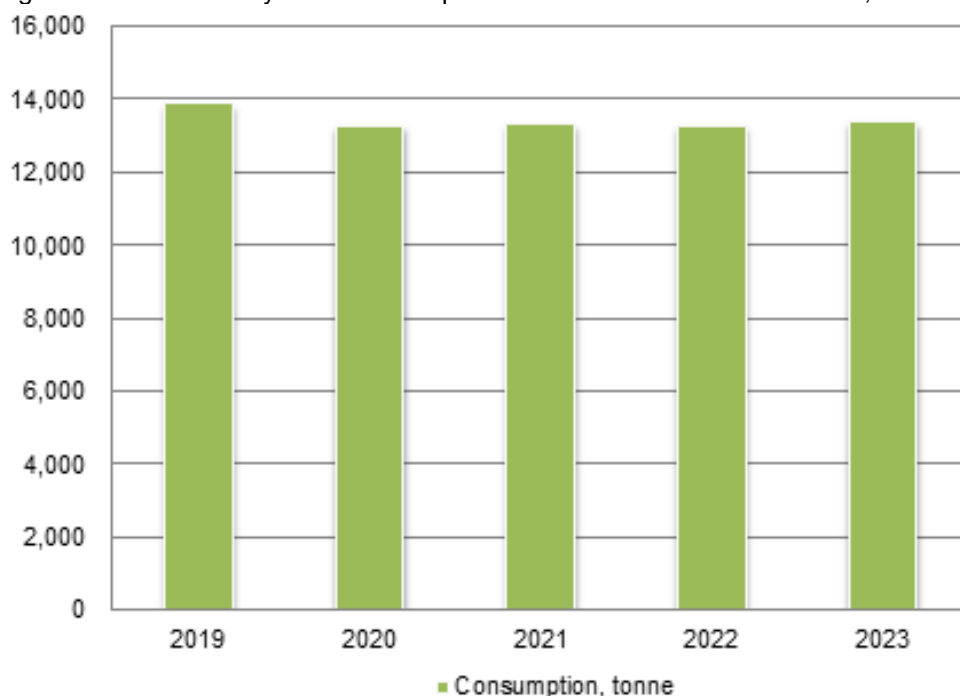
Source:CCM

6.3.5 Others

Pentaerythritol can be made into the following derivatives:

- Pentaerythritol tetranitrate: It is a strong explosive.
- Fatty acid ester is used as plasticizer and stabilizer to make high temperature/insulation PVC. It is a fast growing area, especially under the influence of the RoHS Directive and WEEE Directive.
- Antioxidant 1010 (tetra (β -(3,5-ditertbutyl-4-hydroxy phenyl) propionate)): It is used in rubber, plastic anti-aging agents, antioxidants and so on.
- Antioxidant 618 (distearic pentaerythritol diphosphite) for ABS resin, PS, PC, etc.
- Antioxidant 626 (bis-(2,4-di-tert-butyl-pheny)-phosphiterythritol diphosphite): It is used in the production of plastics.
- Polyisobutylene pentaerythritolate: It is an antioxidant.
- Pentaerythritol triacrylate: It is used in coatings, inks, adhesives, light polymers and other fields.
- Pentaerythritol and neopentleglycol-pentaerythritol binary system for heat storage materials.
- Cyclohexanone pentaerythritol ketal for deforming agents.
- Polyoxyethylene polyoxypropylene pentaerythritol ether: It can be used as an emollient and anti-caking agent in personal care products, and as a food processing aid, etc.

Figure 6.3.5-1 Pentaerythritol consumption volume in other fields in China, 2019–2023



Source:CCM

With the transformation and upgrading of China's economy and strengthening of environmental protection, standards of chemical industry need to be improved continuously, which is bound to affect the supply of pentaerythritol. On the whole, the consumption volume of pentaerythritol in other industries has declined since early 2010s.

During 2016–2018, the consumption volume of pentaerythritol in other industries increased at a CAGR of 1.8%, but it decreased slightly in 2019–2020. In 2021, boosted by improvements in the construction sector and other industrial sectors, demand for pentaerythritol in other industries also edged up a bit. In 2022, the consumption volume decreased slightly due to impacts of the COVID-19 and slow economy. In 2023, with China's relaxation of epidemic control measures and slow economic recovery, the consumption of pentaerythritol in other industries increased slightly by 0.8% year on year.

6.4 Consumption of dipentaerythritol in China and main users

Dipentaerythritol is usually used as a raw material in the production of dipentaerythritol hexaacrylate (DPHA) and dipentaerythritol esters, etc. It is widely used in coating, aerospace, polymer industries and other fields. The end products have excellent comprehensive performance and score higher in environmental protection.

Thanks to increased demand for high-end products and improved awareness of environmental protection, the consumption of dipentaerythritol increased rapidly from 446 tonnes in 2019 to 1,564 tonnes in 2023.

- Dipentaerythritol hexaacrylate (DPHA)

In China, the largest end use segment of dipentaerythritol is DPHA. The rapid development of DPHA's downstream products kept the DPHA industry growing in recent years. Ultraviolet curing coating (UVCC), the largest consumer of DPHA in China, has the advantages of environmental friendliness, fast curing, high hardness and abrasion resistance. With the improvement of environmental consciousness, UVCC is becoming more and more popular in China.

- Dipentaerythritol esters

Dipentaerythritol esters are another major downstream products of dipentaerythritol. They are used to make lubricants with strong oxidizability and high thermal stability, which are used in machines working in high temperatures, such as turbojet engines. The demand from dipentaerythritol esters for dipentaerythritol has increased slower than that from DPHA, mainly due to the high price and low usage amount of dipentaerythritol esters.

6.5 Consumption of tripentaerythritol in China

Tripentaerythritol is an emerging high-end petrochemical product, as well as a basic chemical raw material with high added value and high technology content. At present, there are only a few developed countries in the world that can mass produce tripentaerythritol, such as the US, Canada and Germany.

China still awaits breakthroughs in the production technology of tripentaerythritol. At present, only a few manufacturers can produce tripentaerythritol, which greatly limits the application of tripentaerythritol. Moreover, production of tripentaerythritol in Chinese producers still faces problems of low yield, difficulty in separation and low purity.

Downstream products of tripentaerythritol are mainly used in the synthesis of high-end coatings (such as tripentaerythritol octaacrylate) and high-grade lubricants (such as tripentaerythritol hexastearate) in China.

In 2023, the consumption of tripentaerythritol in China was 74 tonnes.

7 Future forecast

7.1 Key factors and driving forces for development

- Environmental pressure

At present, the Chinese government attaches more importance to pollution control and energy conservation. Since there is still some pollution in the production of pentaerythritol, environmental supervision and examination will directly affect operation of pentaerythritol producers. In 2016–2017, Hubei Yihua stopped the pentaerythritol production line in the Yichang factory. This period also saw a decline in pentaerythritol output in Baoding Guoxiu which is located in the Beijing-Tianjin-Hebei region, where the pentaerythritol production is seriously influenced by environmental pressure. Baoding Guoxiu stopped production from April 2020, after a required relocation by authorities in Hebei Province.

Due to stricter environmental regulations and the improvement of environmental standards, pentaerythritol producers will face higher environmental costs, which will encourage them to improve their technological routes to meet environmental standards. Companies with better environmental protection facilities have a clear advantage.

- Competition

In recent years, new competitors have entered the pentaerythritol industry in China, and multiple manufacturers have exited the market or reduced production capacity due to environmental factors. The total production capacity of pentaerythritol in China has shown a fluctuating decline. The industry operating rate of pentaerythritol in China fluctuated slightly around 70% from 2019 to 2023. Obviously, despite the contraction of production capacity, the Chinese pentaerythritol industry still faces overcapacity. In the future, China's pentaerythritol industry will still have new production capacity released, and competition within the industry will become more intense. In addition, the competition for pentaerythritol substitutes will further weaken the bargaining power and profit margins of manufacturers, which may indirectly drive manufacturers to explore overseas markets and seek new profit growth opportunities.

- Domestic downstream market

The main downstream market of pentaerythritol is alkyd resin, which accounted for more than half of China's pentaerythritol consumption from 2019 to 2023. It is expected that the consumption of pentaerythritol in alkyd resins will slowly decrease, as the fierce competition from acrylic resins will affect the demand for pentaerythritol in their coating industry.

In the future, with the development of downstream industries such as polyurethane, synthetic lubricant, and rosin pentaerythritol ester in China, the demand and consumption of high-grade pentaerythritol will slowly increase, while low-grade pentaerythritol will gradually exit the market. This will force domestic producers of pentaerythritol to continuously carry out technological transformation and optimize product structure to meet changes in market demand.

- Overseas market

From 2019 to 2023, China's export volume of pentaerythritol fluctuated with a CAGR of 7.3%. In 2023, China's export volume of pentaerythritol reached a new high. In the past, Chinese manufacturers placed greater emphasis and focus on the domestic market. As the growth rate of domestic market demand slows down, manufacturers will pay more attention to the development of overseas markets. The production cost and price advantages of pentaerythritol in China still dominate the world, which will be beneficial for manufacturers to explore overseas markets in the short term. In the future, China's export volume of pentaerythritol will maintain a growth trend.

7.2 Outlook for pentaerythritol industry, 2024–2028

- Production

The pentaerythritol industry still faces problems such as high production cost, shrinking profit, weak downstream market and increasing environmental pressure in particular, which will directly affect the output of pentaerythritol. Besides, demand from the largest downstream sector alkyd resin will decrease further.

It is estimated that the output of pentaerythritol will increase at a CAGR of 2.2% from 2024 to 2028.

- Industry concentration

Chifeng Ruiyang and Hubei Yihua occupied about 60% of the Chinese pentaerythritol market in 2019–2023. However, with two new entrants joining the industry, greater changes to the concentration rate have been witnessed. In the future, the industry will experience fiercer competition and small producers will find it difficult to operate under current cost pressures from both raw materials and environmental protection and will cut or suspend their production. This will provide opportunities for leading pentaerythritol producers to expand their market share. Besides, entry barriers to the industry will increase.

- Price level

In the coming years, with the easing of international tensions, the fluctuation of international energy prices will tend to be smoother than in previous years, and the production cost of pentaerythritol will be relatively stable. The price of pentaerythritol will be more affected by demand. In the long run, due to slow domestic demand growth and overcapacity, prices may show a downward trend. In the short term, the price of pentaerythritol will still fluctuate repeatedly due to changes in raw material prices and periodic demand.

- Product structure

At present, the competition in the Chinese pentaerythritol industry becomes more intense. And the demand for high-quality pentaerythritol is increasing in both overseas and domestic markets. Producers have to change their competitive strategies if they want to get more market shares and profits. Therefore, the capacity of low-grade pentaerythritol will continue to decrease, while the capacity of high-grade pentaerythritol, dipentaerythritol and tripentaerythritol will expand in the future. CCM also believes that increasing product differentiation to promote competition is conducive to further optimizing the structure of pentaerythritol industry.

- Export

Currently, the demand in the domestic downstream market is limited. Under the premise of overcapacity and more fierce competition, manufacturers will actively develop overseas markets. Despite facing high transportation costs and significant uncertainty risks, exports can still bring objective profits to producers due to relatively low domestic costs. It is expected that from 2024 to 2028, exports will become an important influencing factor for the growth of China's pentaerythritol production, and the proportion of exports to the total production of pentaerythritol in China will increase.

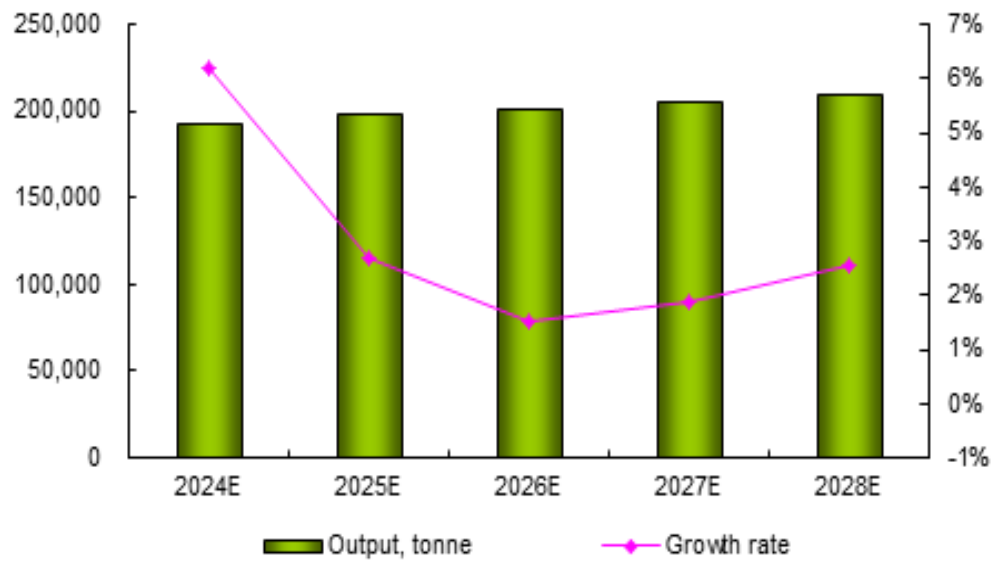
Table 7.2-1 Forecast on pentaerythritol development in China by output share, 2024E–2028E

Year	Monopentaerythritol			Dipentaerythritol	Tripentaerythritol	Total
	Low-grade	Middle-grade	Dipentaerythritol			
2024E	8.2%	46.3%	42.4%	3.0%	0.2%	100.0%
2025E	8.1%	46.3%	42.5%	3.0%	0.2%	100.0%
2026E	8.0%	46.0%	42.7%	3.1%	0.2%	100.0%
2027E	8.0%	45.8%	42.9%	3.1%	0.2%	100.0%
2028E	7.9%	44.1%	44.6%	3.2%	0.2%	100.0%

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

Source: CCM

Figure 7.2-1 Forecast on pentaerythritol output in China, 2024E–2028E



Source:CCM

8 Conclusions

In China, there were ten active pentaerythritol manufacturers in 2023. Both the capacity and output of pentaerythritol in China declined year by year in 2019 and 2020. In 2021, the capacity picked up as two new players entered the industry, and the output also increased. However, in 2022, domestic pentaerythritol capacity decreased, and the output dropped in the face of weak downstream demand. In 2023, production capacity remained stable, while output increased due to an increase in export volume. It is expected that the production of pentaerythritol in China will maintain an increasing trend from 2024 to 2028.

From 2019 to H1 2020, due to a decrease in raw material prices, the price of pentaerythritol decreased. From then until H1 2021, with the increase in raw material prices and demand, prices gradually recovered. But from H2 2022 to May 2023, prices rapidly declined, mainly due to weak demand. Starting from H2 2023, due to the recovery of raw material prices, the price of pentaerythritol began to slowly recover.

In 2019 and 2020, affected by COVID-19, China's export volume of pentaerythritol decreased by 1.3% and 8.4% respectively year on year, and the average export price of pentaerythritol in this period also declined significantly. In 2021, the downward trend has reversed, and overseas demand has driven the growth of China's export volume and price of pentaerythritol. However, in 2022, due to weak overseas demand, the export volume of pentaerythritol experienced another decline. It was not until 2023 that the export volume of pentaerythritol resumed growth due to China's lifting of epidemic control measures. This year, due to the decline in raw material prices, the average export price decreased by 25.0% year on year.

In 2019 and 2020, China's import volume of pentaerythritol stayed below 4,000 tonnes. But it surged to over 5,500 tonnes in 2021 and further rose to nearly 6,400 tonnes in 2022, topping 7,100 tonnes in 2023.

The pentaerythritol industry in China has faced fierce competition, low profit and great environmental pressure, which in fact have affected some manufacturers. For example, Baoding Guoxiu and Shandong IFT are no longer involved in pentaerythritol production.

9 Profile of active pentaerythritol manufacturers

9.1 Chifeng Ruiyang Chemical Co., Ltd.

Address: Yuanbaoshan District, Chifeng City, Inner Mongolia Autonomous Region 024000, P. R. China

Tel.: +86-476-5999183, 5999156, 5999166

Fax: +86-476-5999163

E-mail: ruiyanghuagong@sina.com

Person to contact: Mr. Ma, Mr. Yan

Website: www.nmruiyangchemical.com

- Company background

Chifeng Ruiyang Chemical Co., Ltd. (Chifeng Ruiyang), was established in 2005 and specializes in the production of pentaerythritol, alcohol, trimethylolpropane and other products. The company's registered capital was RMB400 million as of May 2024 and it has obtained certifications of ISO 9001 Quality Management System and ISO 14001 Environmental Management System.

In Oct. 2019, Shanghai Zhongyida Co., Ltd. (stock code: 600610) purchased 100% equity of Chifeng Ruiyang. Before that, Chifeng Ruiyang was a sub-subsidiary of Guizhou Kailin Group Co., Ltd. (Kailin Group). Kailin Group had three pentaerythritol production bases before 2018, namely Jiangsu Kailin Ruiyang Chemical Co., Ltd. (Jiangsu Ruiyang), Chifeng Ruiyang and Guizhou Kailin Xifeng Synthetic Ammonia Co., Ltd.

- Main products

- Pentaerythritol
- Trimethylolpropane
- Alcohol
- Formaldehyde
- Acetaldehyde

- Pentaerythritol

- Chifeng Ruiyang Chemical Co., Ltd.

Chifeng Ruiyang's 5,000 t/a new high-quality pentaerythritol project was built up in 2018. It can produce all three kinds of pentaerythritol with the capacity of 43,000 t/a monopentaerythritol (95%, 98% and 99%), 2,500 t/a dipentaerythritol (85% and 90%) and 200 t/a tripentaerythritol (80%).

- Jiangsu Kailin Ruiyang Chemical Co., Ltd.

Jiangsu Ruiyang permanently stopped pentaerythritol production in 2018.

- Guizhou Kailin Xifeng Synthetic Ammonia Co., Ltd.

There were two production lines in Guizhou Kailin Xifeng Synthetic Ammonia Co., Ltd. (each with 30,000 t/a capacity), one of which was reformed to produce ferric phosphate in 2018. The other is used for the transitional production of pentaerythritol. Whether this production line will be used to produce pentaerythritol depends on market demand. In 2018, Chifeng Ruiyang leased production equipment with capacity of 15,000 t/a from the company to produce pentaerythritol. It permanently stopped pentaerythritol production in 2018.

Table 9.1-1 Capacity and output of pentaerythritol in Chifeng Ruiyang, 2019–H1 2024E

Year	2019	2020	2021	2022	2023	H1 2024E
Capacity, t/a	47,500	45,500	45,500	45,500	45,500	45,500
Output, tonne	43,400	45,550	48,800	49,000	48,800	24,800

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. Usually, the capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol is determined by that of monopentaerythritol. However, as Chifeng Ruiyang has a separate dipentaerythritol production line, the capacity of pentaerythritol in Chifeng Ruiyang is the sum of monopentaerythritol capacity and dipentaerythritol capacity. 2. The output in H1 2024 is an estimate.

Source:CCM

● Technology

Chifeng Ruiyang's process route is sodium method. Its planned calcium method production facilities have not been built due to market changes and technical factors.

• **Sales**

Chifeng Ruiyang's pentaerythritol products have been exported to over 35 countries.

Its key customers are producers in the coating, lubricant and fine chemical businesses as well as chemical traders.

• **Price**

Table 9.1-2 Quotation of pentaerythritol in Chifeng Ruiyang, 2019–2024, USD/t

Specification	Monopentaerythritol		Dipentaerythritol		Tripentaerythritol
	95%	98%	85%	90%	80%
June 2019	1,524	1,713	6,822	N/A	11,612
June 2020	N/A	1,318	4,207	N/A	11,218
June 2021	1,966	2,124	N/A	N/A	N/A
July 2022	1,795	1,944	N/A	N/A	N/A
May 2023	N/A	N/A	N/A	N/A	N/A
March 2024	N/A	N/A	N/A	N/A	N/A

Note: Failed to get its quotations in 2023 and 2024.

Source:CCM

• **Export**

Table 9.1-3 Chifeng Ruiyang's export volume of pentaerythritol, 2019–2023

Year	Export of monopentaerythritol		Export of dipentaerythritol	
	Volume, tonne	Growth rate	Volume, tonne	Growth rate
2019	12,392	-16.7%	1,212	-42.3%
2020	11,361	-8.3%	N/A	/
2021	15,232	34.1%	850	/
2022	12,747	-16.3%	1,292	52.0%
2023	13,938	9.3%	1,424	10.2%

Source:CCM

9.2 Hubei Yihua Chemical Industry Co., Ltd.

Address: No. 52 Yanjiang Avenue, Yichang City, Hubei Province 443000, P. R. China

Tel.: +86-717-8868235; 15901032658; 13886744644

Fax: +86-717-6466258

Person to contact: Mr. Liu; Mr. Huang

Website: www.hbyh.cn

- Company background

Hubei Yihua Chemical Industry Co., Ltd. (Hubei Yihua, former Hubei Yichang Chemical Plant) was founded in 1977. It publically issued 16.35 million RMB-denominated common shares in July 1996 and was listed on the Shenzhen Stock Exchange (SZSE) in Aug. 1996. Hubei Yihua (stock code: 000422) is the first listed nitrogenous fertilizer manufacturer in China.

In 2023, Hubei Yihua achieved revenue of USD2.4 billion (RMB17.0 billion), a 17.7% decrease year on year; the net profit attributable to shareholders of the listed company was USD64.3 million (RMB453.1 million), down by 79.1% over the figure in the previous year.

- Main products

Hubei Yihua mainly engages in the production and sale of fertilizers and chemicals. It had capacity of 1,560,000 t/a urea, 1,260,000 t/a diammonium phosphate, 840,000 t/a polyvinyl chloride (PVC), 640,000 t/a caustic soda, and 70,000 t/a pentaerythritol as of the end of 2023.

1) Major fertilizers

- Urea
- Diammonium phosphate

2) Major chemicals

- Caustic soda
- PVC
- Pentaerythritol
- Sodium hydrosulfite

Other products of the company include formaldehyde, formic acid, liquid chloride, and PVC resin.

- Pentaerythritol

Hubei Yihua focuses on the manufacturing of 95% and 98% monopentaerythritol to fulfill larger market demand for high-end products. It produces dipentaerythritol with a small amount.

Hubei Yihua once had three pentaerythritol factories, which are located in Yidu City of Hubei Province, Wuhai City of Inner Mongolia Autonomous Region, and Yichang City of Hubei Province. But it stopped pentaerythritol production in its Yichang factory for the upgrading of its synthetic ammonia installation in 2017, and thus cut its pentaerythritol capacity by 8,000 t/a to 70,000 t/a. In 2017–2023, the capacity of pentaerythritol of Hubei Yihua in Yidu base and Inner Mongolia base was 40,000 t/a and 30,000 t/a, respectively.

Table 9.2-1 Capacity and output of pentaerythritol in Hubei Yihua, 2019–H1 2024E

Year	2019	2020	2021	2022	2023	H1 2024E
Capacity, t/a	70,000	70,000	70,000	70,000	70,000	70,000
Output, tonne	53,900	52,800	55,200	55,000	57,000	31,500

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.

Source:CCM

● Price

Table 9.2-2 Quotation of pentaerythritol in Hubei Yihua, 2019–2024, USD/t

Specification	Monopentaerythritol		Dipentaerythritol	
	95%	98%	85%	90%
June 2019	1,597	1,742	N/A	N/A
June 2020	1,150	1,346	5,048	N/A
June 2021	1,888	N/A	N/A	N/A
July 2022	1,795	N/A	N/A	N/A
May 2023	1,159	1,419	4,779	N/A
March 2024	1,478	1,618	N/A	N/A

Source:CCM

● Export

Table 9.2-3 Hubei Yihua's export volume of pentaerythritol, 2019–2023

Year	Export volume, tonne	Growth rate
2019	22,906	3.5%
2020	21,916	-4.3%
2021	25,771	17.6%
2022	22,779	-11.6%
2023	25,872	13.6%

Source:CCM

9.3 Puyang Pengxin Chemical Co., Ltd.

Address: West of Shengli Road, Puyang City, Henan Province 457000, P. R. China

Tel.: +86-393-8950030; +86-393-8961860; +86-393-8961018

Fax: +86-393-8961860

E-mail: pengxinchemical@outlook.com

Person to contact: Mr. Zhou

Website: www.pyspx.com

- Company background

Puyang Pengxin Chemical Co., Ltd. (Puyang Pengxin), established in 2002, has total assets of RMB150 million and over 200 employees, covering an area of 77,700 m².

Puyang Pengxin's main capacity include 20,000 t/a pentaerythritol, 1,000 t/a dipentaerythritol, 100,000 t/a formaldehyde, and 13,000 t/a sodium formate. It is also among the first batch of revisors of national standards for pentaerythritol and formaldehyde, as well as industrial standards for dipentaerythritol.

In Aug. 2016, Puyang Pengxin became a co-founder of the Professional Committee of Polyol under the framework of the Formaldehyde Industry Association to enlarge the production scale, advance technology and improve the comprehensive strength of the whole industry.

Puyang Pengxin has been certified to ISO 9001 Quality Management System and ISO 14001 Environmental Management System.

- Pentaerythritol

Puyang Pengxin mainly produces 92%, 95% and 98% monopentaerythritol and 85% and 90% dipentaerythritol. In H1 2024, it mainly produces 95%, 98% monopentaerythritol and 85% dipentaerythritol.

Table 9.3-1 Capacity and output of pentaerythritol in Puyang Pengxin, 2019–H1 2024E

Year	2019	2020	2021	2022	2023	H1 2024E
Capacity, t/a	20,000	20,000	20,000	20,000	20,000	20,000
Output, tonne	17,800	16,600	18,600	19,000	19,500	10,500

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.

Source:CCM

• Sales

In the domestic market, Puyang Pengxin's monopentaerythritol is mainly used for the production of alkyd resin and paint.

• Price

Table 9.3-2 Quotation of pentaerythritol in Puyang Pengxin, 2019–2024, USD/t

Specification	Monopentaerythritol			Dipentaerythritol	
	92%	95%	98%	85%	90%
June 2019	N/A	1,568	1,742	5,080	5,225
June 2020	N/A	1,122	1,136	4,768	N/A
June 2021	N/A	1,888	N/A	N/A	N/A
July 2022	N/A	1,795	N/A	5,982	N/A
May 2023	N/A	1,303	1,448	N/A	N/A
March 2024	N/A	1,337	N/A	N/A	N/A

Source:CCM

9.4 Anhui Jinhe Industrial Co., Ltd.

Address: No. 127 East Street, Lai'an County, Chuzhou City, Anhui Province 239200, P. R. China

Tel.: +86-550-5624224, 5619090, 18805503066, 13956316220

Fax: +86-550-5628694

E-mail: sales-overseas@ajhchem.com

Person to contact: Mr. Zhu, Mr. Chen

Website: www.jinheshiye.com

- Company background

Anhui Jinhe Industrial Co., Ltd. (Anhui Jinhe), set up in Dec. 2006, was listed on the SZSE in July 2011 (stock code: 002597). It achieved a revenue of USD752.6 million (RMB5.3 billion) and a net profit of USD100.0 million (RMB704.2 million) in 2023. As of April 2023, it had over ten subsidiaries including Jinzhisui International Trading (HK) Limited, Jinhe USA LLC and Jinzhisui International Trade (Nanjing) Co., Ltd.

- Main products

1) Food additives

- Acesulfame-K
- Methyl maltol
- Ethyl maltol

2) Chemicals

- Formaldehyde
- Liquid ammonia
- Ammonium bicarbonate
- Nitric acid
- Melamine
- Pentaerythritol
- Neopentyl glycol
- Sulfuric acid and others

- Pentaerythritol

Anhui Jinhe started the commercial production of pentaerythritol in Aug. 2008. It has 20,000 t/a pentaerythritol production capacity and mainly produces 95% monopentaerythritol.

Table 9.4-1 Capacity and output of pentaerythritol in Anhui Jinhe, 2019–H1 2024E

Year	2019	2020	2021	2022	2023	H1 2024E
Capacity, t/a	20,000	20,000	20,000	20,000	20,000	20,000
Output, tonne	19,200	18,050	19,150	19,000	18,800	9,300

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.

Source:CCM

● Technology

Anhui Jinhe uses low-temperature sodium method to produce pentaerythritol. In 2018, the company applied for two patents concerning tripentaerythritol synthesis.

● Sales

Most of the pentaerythritol produced by the company is sold in the domestic market.

- **Price**

Table 9.4-2 Quotation of pentaerythritol in Anhui Jinhe, 2019–2024, USD/t

Specification	Monopentaerythritol		Dipentaerythritol
	93%	95%	85%
June 2019	N/A	1,495	4,790
June 2020	N/A	1,066	3,365
June 2021	N/A	1,966	N/A
July 2022	N/A	1,795	N/A
May 2023	N/A	1,332	N/A
March 2024	N/A	1,238	N/A

Source:CCM

9.5 Bazhou Shengfang United Chemical Co., Ltd.

Address: Xinzhang Industrial Zone, Shengfang Town, Bazhou City, Hebei Province 065701, P. R. China

Tel.: +86-316-7531828, 13603267665

Fax: +86-316-7531828

Person to contact: Mr. Li

- Company background

Bazhou Shengfang United Chemical Co., Ltd. (Bazhou Shengfang)'s predecessor is Shengfang United Formaldehyde Factory, which was founded in 1996 and renamed as United Chemical Co., Ltd. in 2002. Currently, Bazhou Shengfang mainly produces pentaerythritol, sodium formate and formaldehyde with capacity of 15,000 t/a, 7,000 t/a and 170,000 t/a, respectively.

- Pentaerythritol

Bazhou Shengfang's pentaerythritol production line was put into production in April 2008.

The company can produce 80%–90% dipentaerythritol, 93%, 95% and 98% monopentaerythritol. However, at present, the company produces 95% monopentaerythritol only. It is worth noting that Bazhou Shengfang also sells pentaerythritol products from Ningxia Ningshun.

Table 9.5-1 Capacity and output of pentaerythritol in Bazhou Shengfang, 2019–H1 2024E

Year	2019	2020	2021	2022	2023	H1 2024E
Capacity, t/a	15,000	15,000	15,000	15,000	15,000	15,000
Output, tonne	2,800	2,000	2,300	800	700	300

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.

Source:CCM

- **Technology**

Bazhou Shengfang produces pentaerythritol using a low-temperature sodium method, and it uses self-produced formaldehyde as a raw material.

- **Sales**

The company claims that its pentaerythritol is mainly used in coating and paint.

At present, it mainly sells 95% monopentaerythritol. Most of the pentaerythritol produced by the company is sold in the domestic market.

● **Price**

Table 9.5-2 Quotation of pentaerythritol in Bazhou Shengfang, 2019–2024, USD/t

Specification	Monopentaerythritol			Dipentaerythritol
	93%	95%	98%	85%
June 2019	1,524	N/A	N/A	N/A
June 2020	1,094	N/A	N/A	N/A
June 2021	N/A	1,888	N/A	N/A
July 2022	N/A	1,645	N/A	N/A
May 2023	N/A	1,274	1,332	4,489
March 2024	N/A	1,267	1,379	3,659

Source:CCM

9.6 Yunnan Yuntianhua Co., Ltd.

Address: No. 1417 Dianchi Road, Xishan District, Kunming City, Yunnan Province 650228, P. R. China

Tel.: +86-871-64327067, 18987570122

Fax: +86-871-64327155

Person to contact: Mr. Xu

Website: www.yyth.com.cn

- Company background

Yunnan Yuntianhua Co., Ltd. (Yunnan Yuntianhua) was established in 1997 on the basis of the former Yunnan Natural Gas Plant, which was built in 1974 and started production in 1977.

In July 1997, Yunnan Yuntianhua was listed on the Shanghai Stock Exchange (stock code: 600096). By the end of 2023, Yunnan Yuntianhua had total assets of more than USD7.5 billion (RMB52.6 billion) and 11,893 employees. The company mainly engages in the production and sale of fertilizers, fine chemicals, phosphorus chemicals, and fiberglass new materials.

Yunnan Yuntianhua has over 40 subsidiaries.

- Main products

- Fertilizer (monoammonium phosphate, diammonium phosphate, coarse whiting)
- Urea
- Polyformaldehyde
- Pentaerythritol
- Methanol

- Pentaerythritol

Yunnan Yuntianhua's pentaerythritol capacity maintained at 10,000 t/a in 2009–2020, and it reached 11,400 t/a in 2021. Its annual output of pentaerythritol has exceeded 10,000 tonnes since 2014. Even in 2017 when environmental protection inspections became more stringent, it maintained relatively consecutive production thanks to its advanced environmental protection mechanism. In Dec. 2020, Yunnan Yuntianhua completed a technical transformation project for pentaerythritol; it stopped the production of low-grade monopentaerythritol and expanded the production of 98% and 99% monopentaerythritol as well as

dipentaerythritol.

Table 9.6-1 Capacity and output of pentaerythritol in Yunnan Yuntianhua, 2019–H1 2024E

Year	2019	2020	2021	2022	2023	H1 2024E
Capacity, t/a	10,000	10,000	11,400	11,400	11,400	11,400
Output, tonne	13,000	12,300	11,000	13,000	13,100	7,000

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.

Source:CCM

• Technology

Introduced from Eurotecnica Contractors and Engineers S.P.A., the pentaerythritol production process in Yunnan Yuntianhua includes reaction, condensation, crystallization and filtration, re-crystallization and filtration, drying and packaging, recycling methanol, formaldehyde, and recycling of sodium formate. The total investment for this project was USD27 million. This large-scale production line was based on the low-temperature sodium pathway, which is highly automated and productive. It can yield high-quality products, with low cost in feedstock and energy.

Besides, Yunnan Yuntianhua has built special units to treat wastewater and organic waste. These units applied the DCS3000 system from Honeywell Corporation of the US.

• Sales

The company's pentaerythritol products, mainly of top-grade quality, are mostly supplied to domestic customers. Coating and lubricant manufacturers are two of its major downstream clients, with several affiliated coating factories of some international leading enterprises purchasing 98% pentaerythritol from Yunnan Yuntianhua.

• Price

Table 9.6-2 Quotation of pentaerythritol in Yunnan Yuntianhua, 2019–2024, USD/t

Specification	Monopentaerythritol			Dipentaerythritol
	93%	98%	99%	90%
June 2019	N/A	1,858	N/A	/
June 2020	N/A	1,613	N/A	/
June 2021	/	1,966	N/A	N/A
July 2022	/	N/A	N/A	N/A
May 2023	/	N/A	N/A	N/A
March 2024	/	1,435	N/A	N/A

Note:Failed to get its quotations in 2022–2023.

Source:CCM

• Export

According to the contract with Eurotecnica Contractors and Engineers S.P.A, Yunnan Yuntianhua cannot export its pentaerythritol to Europe and the US. Yunnan Yuntianhua believes that it is a mistake to sign such an agreement because of the large international market demand in recent years. It claims that about 20%–30% of its products are exported to India or Southeast Asia.

The company also exports pentaerythritol through one of its joint ventures in Chongqing City, named Chongqing Polycomp International Corp.

9.7 Shijiazhuang Shuangyan Chemical Co., Ltd.

Address: Jinzhou Economic Development Zone, Shijiazhuang City, Hebei Province 052260, P. R. China
 Tel.: +86-311-83160328, 15933601073
 Fax: +86-311-84455221
 Person to contact: Mr. Chen

- Company background

Shijiazhuang Shuangyan Chemical Co., Ltd. (Shijiazhuang Shuangyan), established in 2013, is an enterprise that produces chemical raw materials. Currently, it mainly produces monopentaerythritol, dipentaerythritol, sodium formate, formaldehyde, etc., which are widely used in industries such as coating and paint.

- Pentaerythritol

Shijiazhuang Shuangyan has 10,000 t/a pentaerythritol capacity and mainly produces 95% monopentaerythritol and 85% & 90% dipentaerythritol.

Table 9.7-1 Capacity and output of pentaerythritol in Shijiazhuang Shuangyan, 2019–H1 2024E

Year	2019	2020	2021	2022	2023	H1 2024E
Capacity, t/a	10,000	10,000	10,000	10,000	10,000	10,000
Output, tonne	7,400	5,500	6,800	6,500	6,800	3,200

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.

Source:CCM

• Technology

Shijiazhuang Shuangyan produces pentaerythritol using a high-temperature sodium method, and it also uses formaldehyde produced by itself as pentaerythritol's raw material.

• Sales

The company claims that its pentaerythritol is mainly used in coating and paint. Most of the pentaerythritol produced by the company is sold in the domestic market.

• Price

Table 9.7-2 Quotation of pentaerythritol in Shijiazhuang Shuangyan, 2019–2024, USD/t

Specification	Monopentaerythritol	Dipentaerythritol	
	95%	85%	90%
June 2019	1,539	5,225	N/A
June 2020	1,122	4,207	N/A
June 2021	N/A	N/A	N/A
July 2022	N/A	N/A	N/A
May 2023	N/A	N/A	N/A
March 2024	N/A	N/A	N/A

Note:Failed to get its quotations in 2021–2024.

Source:CCM

9.8 Puyang Yongan Chemical Co., Ltd.

Address: West Huanghe Road, High-Tech Development Zone, Puyang City, Henan Province 457000, P. R. China

Tel.: +86-393-4624398, +86-393-4624489, 13080107125

Fax: +86-393-4624496, +86-393-4624296

E-mail: pyyongan@pyinfo.net; yongan@pyyongan.com

Person to contact: Mr. Lei

Website: www.pyyongan.com

- Company background

Puyang Yongan Chemical Co., Ltd. (Puyang Yongan), built on the basis of the former Puyang Biochemical Company, engages in the production and sale of pentaerythritol and formates.

Puyang Yongan self-developed the calcium method to produce pentaerythritol and calcium formate. It started commercial production of pentaerythritol in Nov. 2004. Its production capacity includes 10,000 t/a monopentaerythritol, 2,000 t/a dipentaerythritol, 500 t/a tripentaerythritol, 5,000 t/a calcium formate, and 5,000 t/a sodium formate.

- Pentaerythritol

As monopentaerythritol (85%–92%) in the domestic market was oversupplied and profits of these products were very low, Puyang Yongan has stopped production of 85%–92% monopentaerythritol since 2007.

The company once suspended the production of pentaerythritol in 2014 and 2015 for not being able to meet the environmental protection standards. It restarted its 10,000 t/a pentaerythritol production line in 2016 when the completion of its technological transformation finally allowed the company to fit into the standards.

During 2019–2024, Puyang Yongan produced 95% monopentaerythritol, 85% dipentaerythritol and 80% tripentaerythritol.

Table 9.8-1 Capacity and output of pentaerythritol in Puyang Yongan, 2019–H1 2024E

Year	2019	2020	2021	2022	2023	H1 2024E
Capacity, t/a	10,000	10,000	10,000	10,000	10,000	10,000
Output, tonne	7,700	6,880	7,530	5,200	4,600	2,000

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol and tripentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.

Source:CCM

● Technology

Puyang Yongan adopted the calcium pathway for the production of pentaerythritol before 2018, but due to a lack of raw materials, the company adjusted its pentaerythritol production lines with the sodium pathway.

● Sales

The company sells its products to producers of alkyd resin and rosin resin, which are mainly located in Guangdong and Fujian provinces.

Most of its 95% monopentaerythritol is sold in the domestic market.

• Price

Table 9.8-2 Quotation of pentaerythritol in Puyang Yongan, 2019–2024, USD/t

Specification	Monopentaerythritol		Dipentaerythritol	Tripentaerythritol
	95%	98%	85%	80%
June 2019	1,524	N/A	5,225	10,160
June 2020	1,094	N/A	3,786	9,912
June 2021	N/A	2,124	N/A	N/A
July 2022	1,645	N/A	5,982	N/A
May 2023	N/A	N/A	N/A	N/A
March 2024	N/A	N/A	N/A	N/A

Note: Failed to get its quotations in 2023–2024.

Source:CCM

9.9 Shandong Xinzhiyuan Chemical Co., Ltd.

Address: Caoxian Chemical Industry Park, Pulianji Town, Caoxian County, Heze City, Shandong Province 274400, P. R. China

Tel.: +86-19805301988

Person to contact: Mr. Zhang

- Company background

Shandong Xinzhiyuan Chemical Co., Ltd. (Shangdong Xinzhiyuan) is a private enterprise founded in Feb. 2019. It covers an area of 113,680 m² with a total construction area of 39,730 m². The company engages in the production and sale of chemical products, decorative paper and environment-friendly resin glue.

- Pentaerythritol

Shangdong Xinzhiyuan started commercial production of pentaerythritol in Nov. 2021. Its capacity includes 30,000 t/a 95% monopentaerythritol and 1,000 t/a 85% dipentaerythritol.

Table 9.9-1 Capacity and output of pentaerythritol in Shandong Xinzhiyuan, 2021–H1 2024E

Year	2021	2022	2023	H1 2024E
Capacity, t/a	30,000	30,000	30,000	30,000
Output, tonne	4,200	6,400	7,000	5,200

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol and tripentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.

Source:CCM

• Technology

Shangdong Xinzhiyuan produces pentaerythritol using a high-temperature sodium method. Its formaldehyde is self-produced.

• Price

Table 9.9-2 Quotation of pentaerythritol in Shandong Xinzhiyuan, 2023–2024, USD/t

Specification	Monopentaerythritol		Dipentaerythritol
	95%	98%	85%
May 2023	1,274	1,419	4,779
March 2024	1,295	1,435	N/A

Source:CCM

9.10 Ningxia Ningshun New Material Technology Co., Ltd.

Address: Ningdong Chemical New Material Park, Yinchuan City, Ningxia Hui Autonomous Region 750000, P. R. China
 Tel.: +86-15129501279; +86-951-8563179
 Person to contact: Mr. Wu

- Company background

Established in Dec. 2018, Ningxia Ningshun New Material Technology Co., Ltd. (Ningxia Ningshun) is a private enterprise. Its main businesses cover the production of formaldehyde, polyols and their downstream products.

- Pentaerythritol

Ningxia Ningshun has 20,000 t/a monopentaerythritol and 1,000 t/a dipentaerythritol capacities. Its commercial production began in Oct. 2021.

Table 9.10-1 Capacity and output of pentaerythritol in Ningxia Ningshun, 2021–H1 2024E

Year	2021	2022	2023	H1 2024E
Capacity, t/a	20,000	20,000	20,000	20,000
Output, tonne	2,100	5,000	5,400	3,700

Note:1. Dipentaerythritol and tripentaerythritol are byproducts during the production of monopentaerythritol. The capacity of monopentaerythritol equals that of pentaerythritol, and the output of dipentaerythritol and tripentaerythritol is determined by that of monopentaerythritol. 2. The output in H1 2024 is an estimate.
 Source:CCM

• Price

Table 9.10-2 Quotation of pentaerythritol in Ningxia Ningshun, 2022–2024, USD/t

Specification	Monopentaerythritol		Dipentaerythritol
	95%	98%	90%
July 2022	1,550	1,810	5,213
May 2023	1,245	1,332	4,489
March 2024	N/A	N/A	N/A

Note:Failed to get its quotations in 2024.
 Source:CCM

10 Overview of pentaerythritol market in China, 2021–2025

Table 10-1 Overview of pentaerythritol market in China, 2021–2025E, tonne

Item	Number of producers as of 2023	Pentaerythritol														
		2021			2022			2023			2024E			2025E		
		Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth
Manufacturers	10	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Capacity, t/a	/	263,900	/	13.5%	251,900	/	-4.5%	251,900	/	0.0%	251,900	/	0.0%	266,900	/	6.0%
Output	/	179,880	150.6%	9.9%	178,900	149.4%	-0.5%	181,700	151.5%	1.6%	192,950	160.5%	6.2%	198,100	163.7%	2.7%
Demand																
Alkyd resin	>20	68,000	56.9%	-1.6%	67,800	56.6%	-0.3%	67,500	56.3%	-0.4%	67,200	55.9%	-0.4%	66,800	55.2%	-0.6%
Polyurethane	>30	16,600	13.9%	1.2%	16,900	14.1%	1.8%	17,150	14.3%	1.5%	17,300	14.4%	0.9%	17,600	14.5%	1.7%
Synthetic lubricant	>50	12,000	10.0%	1.7%	12,100	10.1%	0.8%	12,200	10.2%	0.8%	12,400	10.3%	1.6%	12,600	10.4%	1.6%
Rosin pentaerythritol ester	>20	9,500	8.0%	1.1%	9,650	8.1%	1.6%	9,700	8.1%	0.5%	9,800	8.1%	1.0%	10,200	8.4%	4.1%
Others	>100	13,350	11.2%	0.4%	13,300	11.1%	-0.4%	13,400	11.2%	0.8%	13,550	11.3%	1.1%	13,800	11.4%	1.8%
Total		119,450	100.0%	-0.5%	119,750	100.0%	0.3%	119,950	100.0%	0.2%	120,250	100.0%	0.3%	121,000	100.0%	0.6%
Apparent Consumption		119,450	100.0%	-0.5%	119,750	100.0%	0.3%	119,950	100.0%	0.2%	120,250	100.0%	0.3%	121,000	100.0%	0.6%

Note: Output share=Output/Apparent consumption
Source:CCM

Table 10-2 Overview of monopentaerythritol market in China, 2021–2025, tonne

Item	Monopentaerythritol														
	2021			2022			2023			2024E			2025E		
	Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth
Manufacturers (10)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Capacity, t/a	261,400	/	13.7%	249,400	/	-4.6%	249,400	/	0.0%	249,400	/	0.0%	264,400	/	6.0%
Output	174,800	147.7%	9.6%	173,620	146.8%	-0.7%	176,030	148.8%	1.4%	186,950	157.6%	6.2%	191,870	160.8%	2.6%
Import volume	5,503	4.6%	42.0%	6,318	5.3%	14.8%	7,095	6.0%	12.3%	5,230	4.4%	-26.3%	5,811	4.9%	11.1%
Sweden	3,276	59.5%	14.2%	4,033	63.8%	23.1%	3,836	54.1%	-4.9%	2,149	41.1%	-44.0%	2,500	43.0%	16.3%
Japan	0	/	/	0	/	/	0	/	/	0	/	/	0	/	/
Taiwan Province	1,770	32.2%	129.6%	1,830	29.0%	3.4%	2,849	40.2%	55.7%	2,314	44.2%	-18.8%	2,400	41.3%	3.7%
Germany	348	6.3%	88.6%	260	4.1%	-25.1%	370	5.2%	42.2%	639	12.2%	72.7%	740	12.7%	15.8%
Others	110	2.0%	111.9%	195	3.1%	77.2%	40	0.6%	-79.5%	128	2.4%	220.0%	171	2.9%	33.6%
Total	5,503	100.0%	42.0%	6,318	100.0%	14.8%	7,095	100.0%	12.3%	5,230	100.0%	-26.3%	5,811	100.0%	11.1%
Export volume	61,923	52.3%	41.0%	56,182	47.5%	-9.3%	64,840	54.8%	15.4%	73,580	62.0%	13.5%	78,390	65.7%	6.5%
Apparent Consumption	118,381	100.0%	-0.9%	118,256	100.0%	-0.1%	118,285	100.0%	0.0%	118,600	100.0%	0.3%	119,291	100.0%	0.6%

Note: Output share=Output/Apparent consumption
Import share=Import volume/Apparent consumption
Export share=Export volume/Apparent consumption
Source:CCM

Table 10-3 Overview of dipentaerythritol market in China, 2021–2025, tonne

Item	Dipentaerythritol														
	2021			2022			2023			2024E			2025E		
	Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth	Quantity	Share	Growth
Manufacturers (10)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Capacity, t/a	13,000	/	19.3%	12,400	/	-4.6%	12,400	/	0.0%	12,400	/	0.0%	13,400	/	8.1%
Output	4,950	481.6%	22.2%	5,100	357.1%	3.0%	5,420	346.5%	6.3%	5,700	365.4%	5.2%	5,900	363.1%	3.5%
Import volume	24	2.3%	11.8%	42	2.9%	77.0%	59	3.8%	40.1%	60	3.8%	1.7%	75	4.6%	25.0%
Germany	24	99.2%	114.5%	40	95.7%	70.8%	58	98.7%	43.9%	59	98.3%	1.7%	72	96.0%	22.0%

Sweden	0	/	/	0	/	/	0	/	/	0	/	/	0	/	/
South Korea	0	/	/	1	2.1%	/	1	1.3%	/	1	1.7%	11.1%	0	/	-100.0%
Japan	<1	0.1%	-99.7%	<1	<0.1%	-9.1%	<1	<0.1%	0.0%	0	0.0%	0.0%	1	1.3%	/
Others	<1	0.8%	-81.3%	1	2.1%	401.1%	0	0.0%	-100.0%	0	0.0%	0.0%	2	2.7%	100.0%
Total	24	100.0%	11.8%	42	100.0%	77.0%	59	100.0%	39.5%	60	100.0%	1.7%	75	100.0%	25.0%
Export volume	3,946	383.9%	9.1%	3,714	260.1%	-5.9%	3,915	250.3%	5.4%	4,200	269.2%	7.3%	4,350	267.7%	3.6%
Apparent Consumption	1,028	100.0%	126.4%	1,428	100.0%	38.9%	1,564	100.0%	9.5%	1,560	100.0%	-0.3%	1,625	100.0%	4.2%

Note: Output share=Output/Apparent consumption
Import share=Import volume/Apparent consumption
Export share=Export volume/Apparent consumption
Source:CCM

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17th Floor, Huihua Commercial & Trade Building, No.80 XianlieZhong Road Guangzhou, 510070, P. R. China

Tel:+86-20-37616606

Fax:+86-20-37616768

E-mail:econtact@cnchemicals.com

Website:www.cnchemicals.com