CCM Data & Business Intelligence

Survey of Fluorine Industry in China 2023

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Executive summary

Fluorine industry has been one of the fastest developing and most promising chemical industries in China. China has become one of the largest production and consumption areas of fluorine chemicals. There are four important sectors for China's fluorine industry, consisting of inorganic fluoride, fluorine refrigerant, fluor polymer and fluor-intermediate.

According to statistics from the United States Geological Survey, China's fluorite reserves remained at 42 million tonnes from 2018–2021 and rose to 49 million tonnes in 2022, ranking second in the world. In 2021–2022, China's fluorite output stayed above 5 million tonnes. To protect the fluorite resources, China has established fluorite industry access standards and issued strict policies.

Great progress has been made in the research and development of inorganic fluorides in China. Inorganic fluorides have been widely used in chemical, mechanical, optical instrument, electronic and medical fields and have become important chemical products in the national economy. China is the largest producer of anhydrous hydrogen fluoride, aluminum fluoride and cryolite in the world, with the production capacity of 2,866,000 t/a, 1,498,000 t/a and 551,000 t/a respectively in 2022. In addition, the production of lithium hexafluorophosphate has developed fast in the past five years and its capacity reached 123,664 t/a in 2022.

China agreed to take steps to phase out HCFCs. To achieve targets set in the phaseout plan of HCFCs, China has implemented quota management system for production and use of HCFCs since 2013. In recent years, the total production quotas of HCFCs have seen a general decrease and have been concentrated in large enterprises. In 2022, a decrease was seen in both the output and consumption of R22. As a refrigerant, R22 production dropped because of strict environmental protection policies and the increasing use of other HFCs, but its use as a raw material to produce tetrafluoroethylene has been on the rise. As HFCs have been substituting HCFCs, both the production and consumption of HFCs such as R134a, R32, R125 and R410a have increased. In 2024, quota of the third-generation refrigerants will be implemented, pushing the producers in the industry to compete for more quotas by increasing its production or sales.

There are two main varieties of fluor polymer in China, including fluor resin and fluor rubber. The fluor polymer industry, especially fluor resin, is developing very quickly in China, though still facing many problems such as inefficient technology and the lack of high-end products. PTFE is the principal product of fluor resins in China, followed by PVDF and FEP. Fluor resins are widely used in coatings, sealing, architecture, electronics and other fields. As to fluor rubbers, along with the development of automobile and petrochemical industries, the industry developed rapidly in 2020–2021. However, in 2022, the development of fluor rubbers industry slowed down due to the lack of high-end products and the shrinking of low and medium-end markets.

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 the compilation and analysis of the obtained information. When necessary, checks have been made with all kinds of suppliers regarding market information such as key manufacturers, key end-users, production, consumption, export, demand and so on.

2) Telephone interviews

CCM has carried out extensive telephone interviews in order to track the actual market situation of the fluorine industry in China.

Interviewees cover:

- Major manufacturers of fluorite
- Major manufacturers of inorganic fluorides
- Major manufacturers of organic fluorides
- Major manufacturers of semi-finished products
- Major manufacturers of finished products
- Major traders
- Associations

3) Network search
CCM employs a network to contact industry participants by using B2B website and software.

4) Data processing and presentation

The data collected and compiled is variously sourced from:

CCM's database

- Published articles from periodicals, magazines, journals and third party databases
- Statistics from governments and international institutes
- Telephone interviews with domestic manufacturers, joint ventures, service suppliers and government agencies
- Third-party data providers
- Customs statistics
- Comments from industrial experts
- Information from the Internet

The data have been combined and cross-checked to make the report as accurate and methodologically sound as possible. Throughout the process, a series of discussions have been held within CCM to analyse the data and draw appropriate conclusions.

- Glossary

CAGR: compound annual growth rate
AHF: anhydrous hydrogen fluoride
HCFC: hydrochlorofluorocarbon
R22: difluorochloromethane
R134a: 1,1,1,2-tetrafluoroethane
R32: difluoromethane
R125: pentafluoroethane
R410a: mixture of R32 and R125
HFP: hexafluoropropylene
PTFE: polytetrafluoroethylene
PVDF: polyvinylidene fluoride
CTFE: chlorotrifluoroethylene
VDF: vinylidene fluoride

TFE: tetrafluoroethylene

- Unit

RMB: currency unit in China, also called Yuan
USD: currency unit in the US, also called US Dollar
Tonne: ton, equals to metric ton in this report
/t: per tonne
t/a: tonne per year, tonne per annual
kg: kilogram

Table 1 Exchange rate of USD/CNY, Jan. 2018–Dec. 2023

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
2018	6.5079	6.3045	6.3352	6.2764	6.367	6.4078	6.6157	6.8293	6.8347	6.8957	6.9670	6.9431	6.6070
2019	6.8482	6.7081	6.6957	6.7193	6.7344	6.8896	6.8716	6.8938	7.0883	7.0726	7.0437	7.0262	6.8826
2020	6.9614	6.9249	6.9811	7.0771	7.0690	7.1315	7.0710	6.9980	6.8498	6.7796	6.7050	6.5921	6.9284
2021	6.5408	6.4623	6.4754	6.5584	6.4895	6.3572	6.4709	6.4660	6.4680	6.4604	6.4192	6.3693	6.4615
2022	6.3794	6.3580	6.3014	6.3509	6.5672	6.6651	6.6863	6.7467	6.8821	7.0092	7.2081	7.1225	6.6897
2023	6.9475	6.7492	6.9400	6.8805	6.9054	7.0695	7.2157	7.1283	7.1778	7.1789	7.1778	7.1104	7.0401

Source: The People's Bank of China

1 Brief introduction of fluorine industry in China

Fluorine chemical products with the characteristics of chemical resistance, good resistance in high and low temperatures, aging resistance, low friction, excellent insulation, etc., are widely applied in many fields. In recent years, the fluorine chemical industry has been one of the fastest developing and most promising chemical industries in China.

China's fluorine chemical production can be dated back to the 1950s. With abundant fluorite reserves, the industry has grown into a large-scale one after more than 70-year development. At present, China's fluorine industry is in the process of transformation and upgrading, turning from a producer of primary fluorine chemical products to a producer of fluorine-containing fine chemical products. There are three important sectors of China's fluorine industry.

Fluorite Reserves

- ＞97% Fluorite
- ≤97% Fluorite

Inorganic fluorides

- Anhydrous hydrogen fluoride
- Aluminum fluoride
- Cryolite
- Lithium hexafluorophosphate
- Others

Organic fluorides

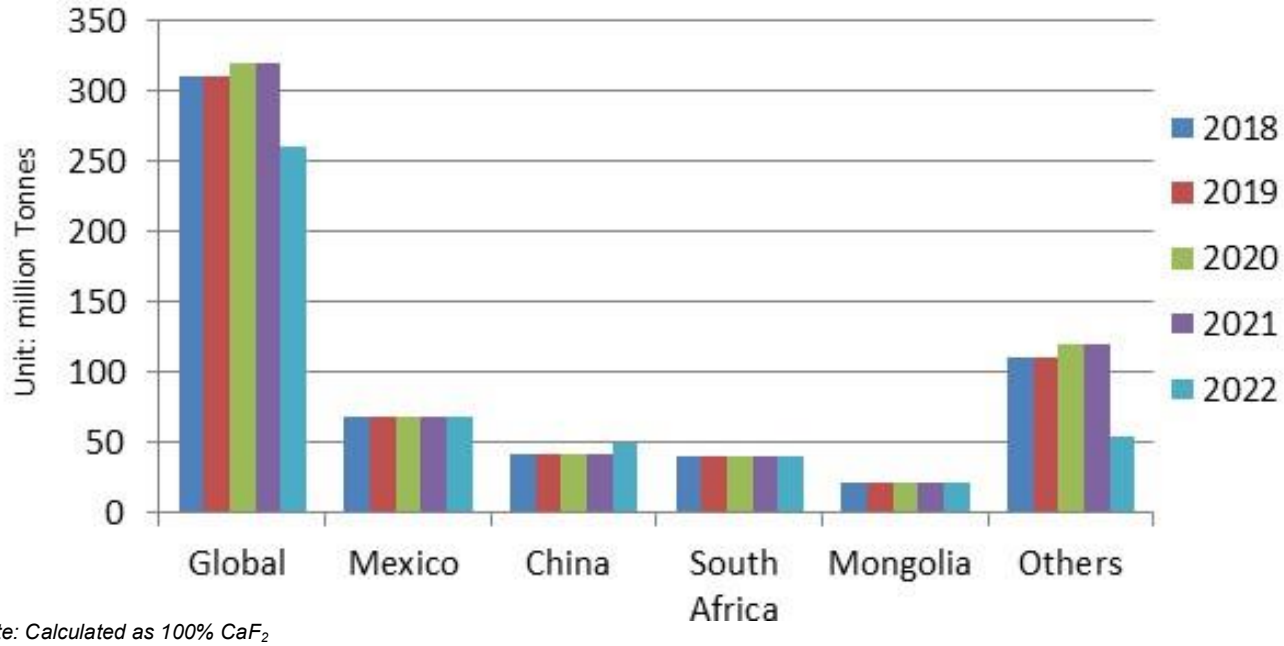
- Refrigerants
  - R22
  - R134a
  - R32
  - R125
  - R410a
  - Others
- Fluor polymers
  - PTFE
  - PVDF
  - FEP
  - Others
- Others

2 Fluorite supply in China

2.1 Overview of fluorite reserves in China

According to statistics from the United States Geological Survey (USGS), global fluorite reserves kept increasing in 2018–2021. Till the end of 2022, there had been about 260 million tonnes of fluorite reserves worldwide. Mexico, China and South Africa are the three countries with largest fluorite reserves, with 68 million tonnes (=26.2%), 49 million tonnes (=18.8%) and 41 million tonnes (=15.8%) respectively in 2022.

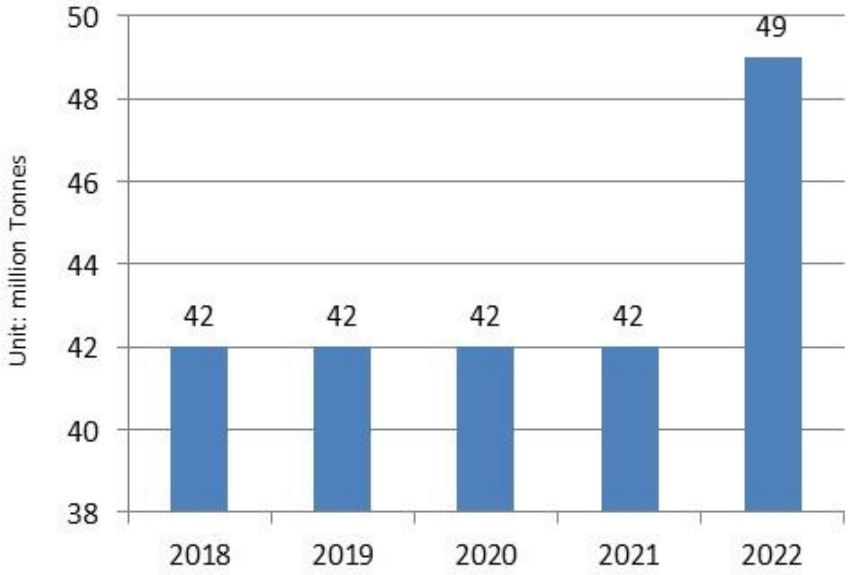
Figure 2.1-1 Global fluorite reserves, 2018–2022



Note: Calculated as 100% CaF_2
Source: USGS

According to the USGS, fluorite reserves in China maintained at 42 million tonnes in 2018–2021, and hit 49 million tonnes in 2022.

Figure 2.1-2 Fluorite reserves in China, 2018–2022



Note:Calculated as 100% CaF_2
Source:USGS

- Characteristics of fluorite reserves in China
  - ● Low impurity content
  - ● Less high-grade ore. The average grade of CaF_2 of a single fluorite ore is about 35%–40%, the fluorite with CaF_2 grade greater than 65% (which can be directly used as metallurgical grade lump ore) only accounts for 20% of the total single fluorite deposits, and that with CaF_2 grade greater than 80% accounts for less than 10% of the total.

- Distribution of fluorite reserves in China
  - ● Jiangxi Province, Inner Mongolia Autonomous Region, Heilongjiang Province, and Hunan Province. Fluorite reserves in Jiangxi Province and Inner Mongolia Autonomous Regions accounted for nearly 50% of the national total.

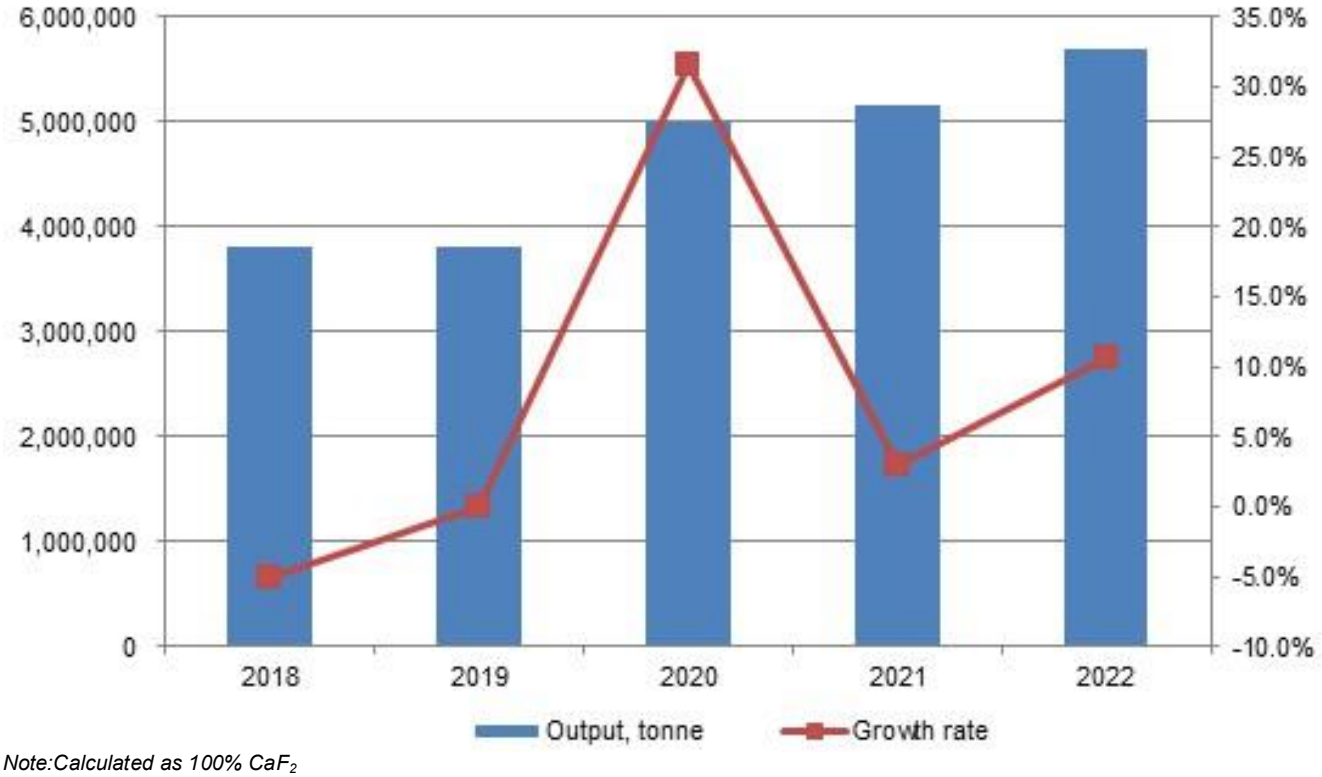
2.2 Production situation of fluorite

Since the end of 2016, environmental protection policies have been tightened, and some mining companies were forced to suspend production due to substandard environmental protection efforts. Among them some could not afford to invest in environmental protection equipment, and others failed to extend their mine safety production licenses (issued by the government every three years).

Strict supervision on the industry and the withdrawal of some manufacturers from the market led to a decline in the fluorite output from 4.0 million tonnes in 2017 to 3.8 million tonnes in 2019. However, the downtrend soon reversed. In 2020, driven by strong downstream demand, the output of fluorite saw great growth; in 2021, the output surpassed 5.1 million tonnes, with an increase of nearly 29% from 2017.

In 2022, the output increased to 5,700,000 tonnes. A production accident led to a four-month shutdown at China Kings Resources Group Co., Ltd., reducing the company's output for the year. After the accident, safety inspections were carried out in Sichuan, Yunnan and Guizhou provinces, and companies with limited strength were eliminated. However, downstream refrigerant producers expanded production to get more quotes for HFCs, and new sectors such as semiconductors, 5G, electronics, and new energy contributed to the output growth in 2022.

Figure 2.2-1 Fluorite production in China, 2018–2022



Note:Calculated as 100% CaF_2
Source:China Non-Metallic Minerals Industry Association & CCM

It is worth mentioning that after fast growth of fluorite production in China in the past, the governments at all levels realized that the resources should be utilized more effectively for sustainable development of fluoride

industry. In 2016, China classified fluorite as one of the strategic mineral resources. With stricter execution of the policies, the position of fluorite will be further strengthened in the industry chain.

Along with the introduction of protection regulations and industry integration policies, fluorite resources will be further concentrated in medium or large enterprises, which is conducive to eliminating small and less skilled mines and companies in the industry.

In China, there are only a few large-scale and influential fluorite enterprises, which are mainly located in provinces and regions with large fluorite resources, such as Zhejiang, Jiangxi and Hunan provinces, and Inner Mongolia Autonomous Region.

Table 2.2-1 Main active fluorite manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	China Kings Resources Group Co., Ltd.	Zhejiang	1,170,000	1,170,000	410,000	472,300
2	Centralfluor Industries Group Inc.	Zhejiang	550,000	550,000	330,000	320,000
3	Yizhang Hongyuan Chemical Co., Ltd.	Hunan	510,000	510,000	306,000	330,000
4	Zhejiang Wuyi Shenlong Flotation Co., Ltd.	Zhejiang	420,000	420,000	252,000	330,000
5	Inner Mongolia Yonghe Fluorochemical Co., Ltd.	Inner Mongolia	400,000	400,000	240,000	215,500
6	Luoyang Fengrui Fluorine Co., Ltd.	Henan	400,000	400,000	240,000	126,200
7	Hunan Nonferrous Chenzhou Fluoride Chemical Co., Ltd.	Hunan	300,000	300,000	180,000	138,400
8	Chengde Yingke Fine Chemical Co., Ltd.	Hebei	290,000	290,000	174,000	220,000
9	Hunan Wanghua Fluorite Mining Co., Ltd.	Hunan	260,000	260,000	156,000	150,000
10	Zhejiang Wuyi Sanlian Industrial Development Co., Ltd.	Zhejiang	210,000	210,000	126,000	110,000
11	Luoyang Fluoride Potassium Technology Co., Ltd.	Henan	200,000	200,000	120,000	93,100
Others			3,390,000	2,990,000	3,166,000	2,644,500
Total			**8,100,000**	**7,700,000**	**5,700,000**	**5,150,000**

Note:1. Calculated as 100% CaF_2 2. The data of some producers are estimated.
Source: CCM

2.3 Price

Since 2017, benefiting from the recovery of the entire commodity sector and the incremental demand brought by the emerging fluorine chemical industry, the downstream demand for fluorite has been strong, and the mismatch between supply and demand has led to a surge in fluorite prices. From June to Aug., the price of fluorite (CaF_2＞97%, same below) decreased temporarily, mainly due to the decline in demand from downstream refrigerant manufacturers; As the inventory was consumed and strong demand from downstream sectors came in H2, the price rocketed rapidly from USD307/t in Sept. and reached USD450/t in April 2018.

The price trend in 2018 can be roughly divided into three stages:

- From Jan. to mid-April, domestic market price of fluorite rose slightly. Some manufacturers suspended for overhaul or reduced production, and most fluorite flotation plants in North China were shut down due to local severe cold weather, which led to a supply decline; yet demand for fluorite increased as spring is the peak season for downstream refrigerant industry.

- From late April to Sept., the price fell sharply but upped a bit quickly. Increasing supply brought the price down as the operating rate recovered in domestic fluorite enterprises with the temperature rising.
- From early Oct. to Dec., the monthly price jumped to USD499/t at last, the highest level in recent years. Main reasons for the sharp increase are as follows:
  - First, governments at multiple levels conducted strict environmental protection investigations, so operating rates of fluorite producers reduced. In 2018, the national environmental protection team inspected fluorite enterprises in provinces and regions such as Inner Mongolia, Jiangxi, Fujian, and Zhejiang, which led to the phased shutdown of some mines and flotation units. As a result, the spot supply of fluorite tightened. Some traders held the goods and waited, also making the price of fluorite relatively high.
  - Second, the seasonal output of fluorite in the North decreased. As temperature declined, the fluorite flotation unit in Inner Mongolia constantly stopped operation, so the supply of fluorite decreased.
  - Third, demand from downstream refrigeration industry was at a high level. Coupled with the booming new refrigerant market, it had brought some favorable support to the price of fluorite.

In 2019, subject to the Sino-US trade conflict and weak economic growth in major global economies, the demand for fluorite from downstream industries reduced. Fluorite price fell from USD499/t, the highest in Dec. 2018, to USD414/t in Dec. 2019. Declining demand from downstream industries did affect fluorite prices in 2019, yet it didn't mean that fluorite was in oversupply. Under harsher environmental protection regulations and frequent inspections, the price was still quite high compared with those in previous years.

In 2020, fluorite price rose in Q1 but plummeted in Q2, and then fluctuated slightly in Q3–Q4. The March price jumped to USD458/t. The supply of fluorite in the market was tight due to low operating rates of the producers, but downstream manufacturers were active in purchasing, which drove the price up. As demand subsided, the price fell to USD369/t in May, and the market did not improve much until the end of the year.

The price curve of fluorite in 2021 showed an "up-down-up" pattern. Specifically:
- In Jan.–March: Fluorite price rose slightly mainly because of the low operating rates of the producers affected by cold weather. Thus the supply of fluorite was insufficient.
- In April–July: Fluorite price declined a little. With many fluorite enterprises resuming production and the operating rates increasing, there was sufficient supply of fluorite, while downstream demand was still weak.
- In Aug.–Dec.: Fluorite price picked up due to declined supply in colder weather and stronger downstream demand.

Fluorite price in 2022 was relatively stable during the recent five years, except for a sharp increase from USD410/t in Nov. to USD465/t in Dec. Specifically:
- In Jan.–April: In this period, fluorite price first fell then rose. The fall was mainly caused by the suspension of major producers with the colder weather and spring festival, but the price started to climb up when those manufacturers reopened their production lines, which boosted the price until April.
- In May–Oct.: Fluorite prices fluctuated during this period while showing a downward trend in general.
- In Nov.–Dec.: The price of fluorite dropped to the lowest of the year at USD410/t in Nov., but soon it surged dramatically to a peak in 2022 at USD465/t. Primarily, fluorite demand remained stable in this period but the supply was short caused by the suspension of some Canadian and Mexican fluorite mines gave rise to the surge. Meanwhile, the low operating rate of fluorite mines in China was also one of the drives.

In H1 2023, fluorite price fluctuated significantly within the range of USD431/t–USD477/t.

Figure 2.3-1 Monthly ex-works price of fluorite (CaF_2＞97%) in China, Jan. 2018–June 2023

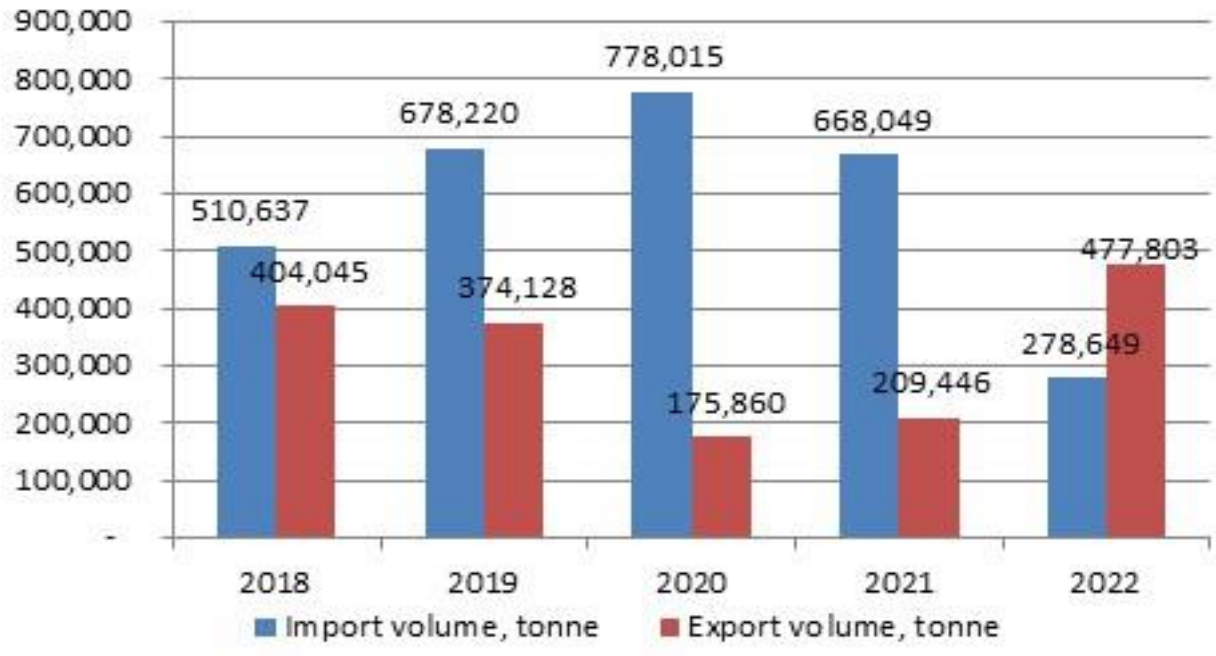
Source: CCM

2.4 Export and import

In 2022, China's export and import volume of fluorite reached their highest and lowest levels in the last five years, respectively. As for imports, the volume in 2022 showed a sharp decrease to 278,649 tonnes compared with a peak of 778,015 tonnes in 2020. On the other hand, the exports recorded a new high at 477,803 tonnes in 2022. The significant fluctuation was mainly due to transportation issues on the Mongolia-China border and the suspension of Koura mine in Mexico, making some of the international fluorite traders turn to import fluorite from China and thereby giving a boost to China's fluorite exports to in 2022,

It is expected that in the coming years, export and import volume will return to normal.

Figure 2.4-1 Import and export volume of fluorite in China, 2018–2022



Note:Fluorite (CaF_2＞97%) and fluorite (CaF_2≤97%) are included.
Source:China Customs & CCM

Table 2.4-1 Imports and exports of fluorite (CaF_2＞97%) in China, 2018–2022

Year	Import			Export		
	Volume, tonne	Value, USD	Annual average price, USD/t	Volume, tonne	Value, USD	Annual average price, USD/t
2018	90,950	27,299,068	300	201,948	80,380,612	398
2019	109,785	32,715,939	298	190,593	78,077,186	410
2020	170,313	46,655,533	274	70,702	29,890,894	423
2021	116,066	32,489,317	280	47,358	20,430,990	431
2022	22,253	6,853,709	308	235,683	109,852,353	466

Note:CaF_2>97%: containing more than 97% calcium fluoride by weight
Source:China Customs & CCM

Table 2.4-2 Imports and exports of fluorite (CaF_2≤97%) in China, 2018–2022

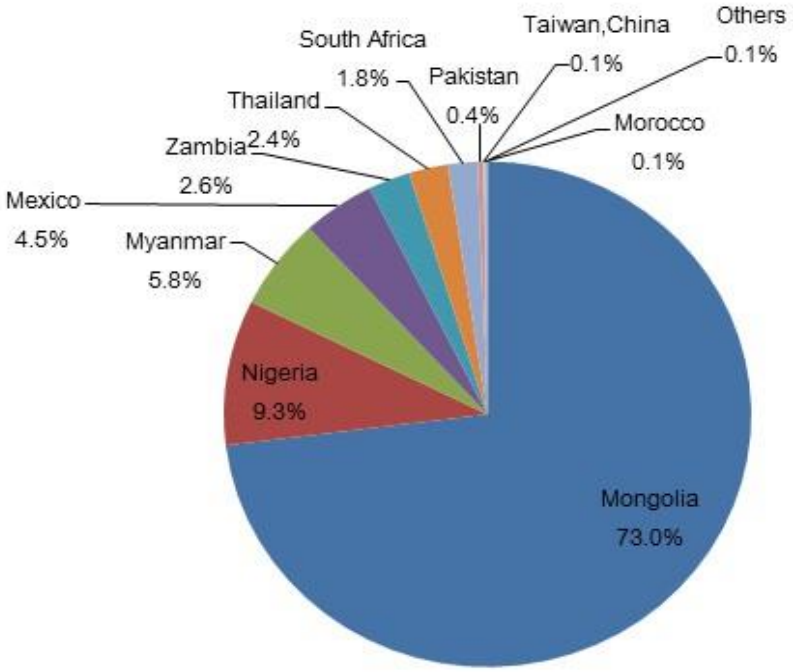
Year	Import			Export		
	Volume, tonne	Value, USD	Annual average price, USD/t	Volume, tonne	Value, USD	Annual average price, USD/t
2018	419,687	67,842,349	162	202,097	58,090,803	287
2019	568,435	87,655,452	154	183,535	56,534,300	308
2020	607,702	79,097,141	130	105,158	34,634,560	329
2021	551,983	77,888,876	141	162,088	67,154,280	414
2022	256,396	50,089,385	195	242,120	102,406,699	423

Note:CaF_2≤97%: containing no more than 97% calcium fluoride by weight
Source:China Customs & CCM

China's fluorite imports mainly come from countries or regions with rich fluorite reserves worldwide, such as Mongolia, Nigeria, Myanmar, Mexico, etc. In 2022, the largest import origin of fluorite was Mongolia, making up 73.0% of the total volume.

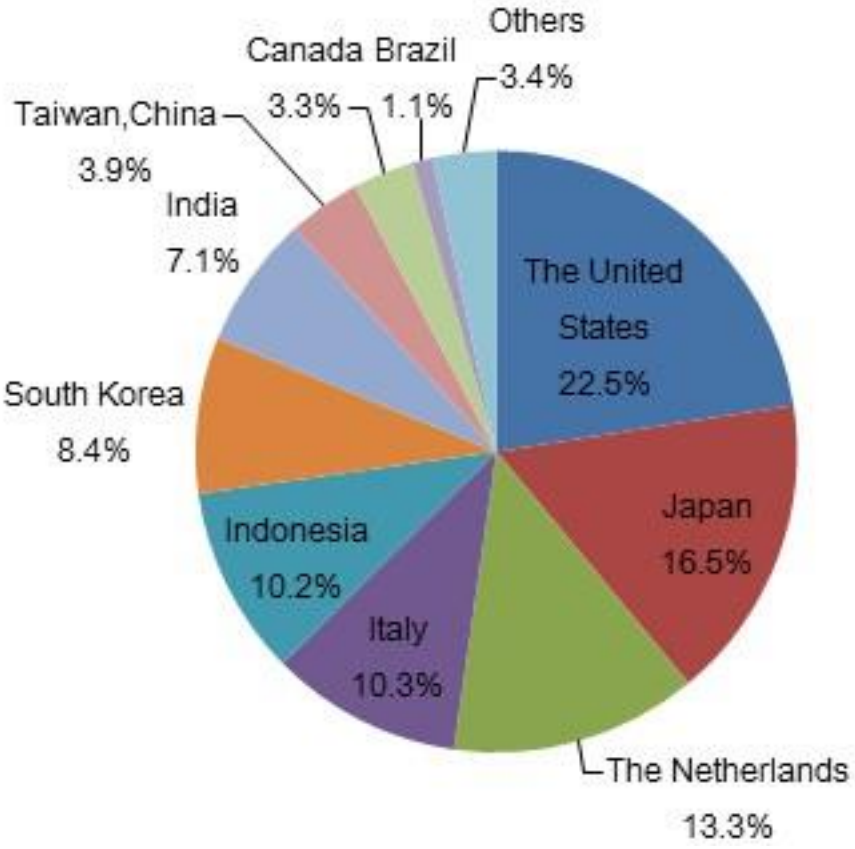
In 2022, China's fluorite were mainly exported to the United States, Japan, the Netherlands, Italy, Indonesia and other Asian countries and regions. This year, the United States was the largest export destination, making up 25.2% of the total volume.

Figure 2.4-2 Top ten fluorite import origins to China by volume, 2022



Note:1. Fluorite (CaF_2＞97%) and fluorite (CaF_2≤97%) are included.
Source:China Customs & CCM

Figure 2.4-3 Top ten export destinations of fluorite from China by volume, 2022



Note:Fluorite (CaF_2＞97%) and fluorite (CaF_2≤97%) are included.
Source:China Customs & CCM

2.5 Forecast trends

- Supply

China investigates new fluorite deposits every year and consumes some of the reserves at the same time. In

recent years, the Chinese government has increased its investment in exploration of fluorite deposits. Therefore, recoverable fluorite reserves in China are likely to keep a steady growth in the next few years.

Although the proven fluorite reserves in China are huge, a large number of deposits are associated fluorite deposits that are difficult to mine or in fluorite mine goafs, or are fluorite mines in natural reserves that are banned from exploiting. Therefore, there are very limited high-value resources that can be used for producing high-quality fluorite products.

In recent years, China has adopted policies to protect the development of fluorite resources. Specifically, higher requirements on production scale, technological level and environmental protection capability of fluorite enterprises have been imposed. With the implementation of industrial policies, fluorite production will be limited. At the same time, downstream demand for fluorite will keep strong. In addition, fluorite is listed as a national strategic mineral. Therefore, fluorite is expected to stay in short supply in China in the long term.

- Price
Although in the long term the industry will keep prosperous, the upward trend will be accompanied by price volatility, like in the recent two years.

- Import and export
With the Belt and Road Initiative, China's fluorite industry can expand channels of acquiring fluorite resources from countries and regions along the road to diversify supply of resources. Mongolia, Myanmar, and Vietnam all have rich fluorite resources. Fluorite products in these countries have an obvious cost advantage, and serve as ever more favorable substitutes. It is predicted that China will gradually increase the import volume of fluorite from these countries, and will participate more actively in the development of overseas fluorite resources and strengthen international cooperation.

3 Inorganic fluorides in China

3.1 Brief introduction of inorganic fluorides in China

Inorganic fluorides include anhydrous hydrogen fluoride (AHF), aluminum fluoride, cryolite, lithium hexafluorophosphate, etc.

- AHF: it is a basic raw material in fluorine industry, produced by fluorite and phosphorus acid, mainly used to produce inorganic and organic fluorides.
- Aluminum fluoride: it is a sandy powder produced by AHF and aluminum oxide, which is mainly used in aluminum smelting to reduce the melting point and improve conductivity of the electrolyte. It is also used as a fluxing agent for ceramic glaze and enamel glaze.
- Cryolite (Na_3AlF_3): it is a fluxing agent, mainly used in the electrolytic production of aluminum. It is also used as a wear-resistant additive for rubber products and grinding wheels, as a whitening agent for enamel, etc.

Nowadays, China produces the above products and the export volumes exceed import significantly.

With the development of new energy, electronic information, semiconductor and pharmaceutical industries and the rising demand for refrigerants, inorganic fluorides, including fluorine electronic chemicals, fluorine-containing special gases, and fluorine-containing fine chemicals, have a bigger market.

3.2 Anhydrous hydrogen fluoride

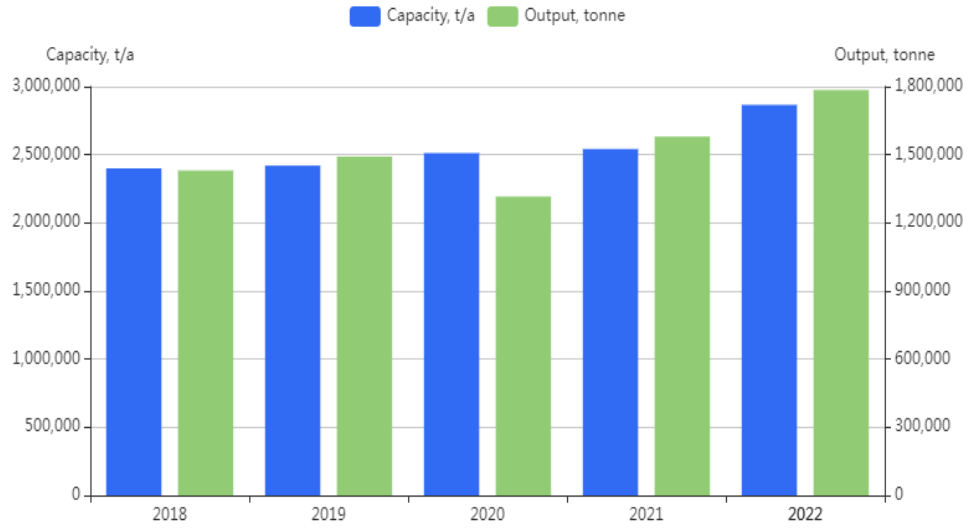
China's anhydrous hydrogen fluoride (AHF) industry started in the 1950s, when it was used to meet the needs of the national defense industry, far from the international level and with low production efficiency. Since then, with the introduction of foreign technology and the continuous expansion of the downstream market of AHF in China, China's AHF industry began to develop and grow gradually. In recent years, China has gradually become a net exporter of AHF, while the import volume is kept at a low level. As one of the raw materials for the fluorine industry growing year by year, China's AHF market is expected to see greater growth in the future.

3.2.1 Production situation

China is the largest anhydrous hydrogen fluoride (AHF) manufacturer in the world. Domestic AHF manufacturers concentrate in Zhejiang, Fujian and Jiangxi provinces, where there are abundant fluorite resources and many downstream users of AHF.

In 2018–2022, China's AHF capacity witnessed a slight increase to 2,866,000 t/a. The output also maintained an overall uptrend, except that the figure in 2020 slipped to 1,316,000 tonnes, due to delayed production resumption and thus decreased operating rate under the COVID-19 pandemic. In 2022, the AHF output rose to 1,785,000 tonnes, up by 13% year on year as national economy continued to recover.

Figure 3.2.1-1 Capacity and output of AHF in China, 2018–2022



Source: CCM

Table 3.2.1-1 Main active AHF manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Do-Fluoride New Materials Co., Ltd. (formerly known as Do-fluoride Chemicals Co., Ltd.)	Henan	270,000	200,000	171,822	160,000
2	Dongyue Group Ltd.	Shandong	210,000	210,000	136,500	150,000
3	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	155,000	85,000	67,000	73,100
4	Qinghai Western Mining Tongxin Chemicals Co., Ltd.	Qinghai	135,000	100,000	110,457	80,000
5	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	131,000	131,000	13,000	129,200
6	Zhejiang Juhua Co., Ltd.	Zhejiang	100,000	115,000	70,000	60,000
7	Shaowu Huaxin Chemical Industry Co., Ltd.	Fujian	50,000	50,000	37,000	45,000
8	Jiangsu Meilan Chemical Co., Ltd.	Jiangsu	50,000	50,000	32,500	40,000
9	Jiangxi Dongyan Pharmaceutical Co., Ltd.	Jiangxi	50,000	50,000	40,000	30,000
10	Jiangxi Shilei Fluorine Chemicals Co., Ltd.	Jiangxi	50,000	50,000	38,000	32,000
11	Hunan Nonferrous Chenzhou Fluoride Chemical Co., Ltd.	Hunan	40,000	40,000	28,400	36,000
12	Shaanxi Yanchang Petroleum Group Fluorosilicon Chemical Co., Ltd.	Shaanxi	40,000	40,000	32,000	30,000
13	Jiangxi Tianxing Chemical Co., Ltd.	Jiangxi	40,000	40,000	40,000	25,000
14	Fujian Shunchang Fubao Tengda Chemical Industry Co., Ltd.	Fujian	35,000	35,000	30,000	28,000
15	Jiangxi Chinafluorine Chemical Co., Ltd.	Jiangxi	35,000	35,000	28,000	21,000
16	Guizhou Wengfu Kailin Fluorosilicon New Material Co., Ltd.	Guizhou	30,000	30,000	25,500	25,000
17	Changshu 3F Fluorochemical Industry Co., Ltd.	Jiangsu	30,000	30,000	25,000	23,000
18	Fujian Yongfu Chemical Co., Ltd.	Fujian	30,000	30,000	20,000	21,000
19	Yantai Zhongrui Chemical Co., Ltd.	Shandong	30,000	30,000	27,000	18,000
20	Luoyang Fluoride Potassium Technology Co., Ltd.	Henan	30,000	30,000	23,000	18,000
Others			1,325,000	1,161,000	789,821	535,700
Total			**2,866,000**	**2,542,000**	**1,785,000**	**1,580,000**

Source: CCM

Capacity in most AHF producers scarcely changed in the past two years, but the capacity in leading enterprises such as Dongyue Group Ltd., Do-Fluoride New Materials Co., Ltd. and Zhejiang Juhua Co., Ltd. increased, because they need more AHF to sustain large-scale production of downstream products.

From 2021 to 2022, the share of top ten Chinese AHF producers by capacity to the national total increased, yet the share of top five by output to the total declined.

Table 3.2.1-2 Capacity and share of main AHF manufacturers in China, 2021–2022

Item	Capacity, 2022		Capacity, 2021	
	Volume, t/a	Share	Volume, t/a	Share
Top five	846,000	29.5%	756,000	29.7%
Top ten	1,201,000	41.9%	1,041,000	41.0%
Total	**2,866,000**	/	**2,542,000**	/

Source: CCM

Table 3.2.1-3 Output and share of main AHF manufacturers in China, 2021–2022

Item	Output, 2022		Output, 2021	
	Volume, tonne	Share	Volume, tonne	Share
Top five	555,779	31.1%	592,300	37.5%
Top ten	743,279	41.6%	805,300	51.0%
Total	**1,785,000**	/	**1,580,000**	/

Source: CCM

3.2.2 Price

In H1 2017, the ex-works price of AHF (99.95%) rose sharply from USD1,073/t to USD1,736/t, up by 61.7%. The main reasons were as follows:

- The price of fluorite, the key raw material of AHF, rose greatly.
- There was a short supply of AHF due to environmental protection pressures, routine maintenance and other factors which resulted in a low operating rate.
- The demand for AHF for the production of downstream refrigerants (like R22) market increased greatly.

After a short time of decline in July–Aug. 2017, the price went up again and rocketed to USD2,371/t in March 2018, the highest price in the past six years. The shortage of fluorite was the main reason for this round of surge.

In 2018, the price of AHF fluctuated dramatically with the highest price reaching USD2371/t in March 2018 while the lowest dived to USD1404/t in May 2018. Specifically:

- In Jan.–Feb.: Main producers overhauled their production lines temporarily due to environmental and safety issues, leading to a short supply of AHF. Seasonal demand of refrigerants also pushed up the price.
- In March–Aug.: AHF price dived significantly as manufacturers resumed production while downstream demand started to abate.
- In Sept.–Dec.: The tight supply of AHF appeared again in the market with more and more major governmental conferences held and producers had to suspend production again to prevent unnecessary inspections.

In 2019, the price fluctuated between USD1,349/t and USD1,868/t. It was deeply affected by the Sino-US trade dispute. With news on the phase-one trade deal between the two countries coming, the price finally stabilized at around USD1,400/t in Q4. In general, the AHF price trend in 2019 can be divided into four stages:

- From Jan. to early April: AHF market price fell sharply, mainly contributed by the following factors—The first is the restart of the AHF devices after maintenance. The supply of AHF was sufficient in the market. Meanwhile, operating rate of upstream raw material fluorite rose slightly, especially in Inner Mongolia and Hebei provinces. On the whole, the supply of fluorite increased, and the falling price of fluorite dragged down AHF price significantly. In addition, sluggish downstream refrigerant market also affected the price.
- From mid-April to mid-July: The price rebounded. During this period, operating rate of domestic refrigerant industry rose slightly. Demand for AHF from the refrigerant sector increased. On the other hand, supply of fluorite was slightly tight. The price of fluorite went up, which strongly supported AHF

price.

● From late July to mid-Nov.: The price of AHF fluctuated. The operating rate of AHF was about 60%. Spot AHF was sufficient while downstream refrigerant production was at a low level. Demand for upstream fluorite and AHF was poor. Specifically, operating rate of refrigerant R22 was around 50%. The operating rate of R134a remained low. Market demand for refrigerants was moderate and mainly for export.

● From the end of Nov. to the end of the year: AHF price rose slightly. Fluorite mining and flotation operated normally. As automotive industry was active in stocking, the supply of R22 was tight.

In H1 2020, the price first climbed to USD1,625/t in March, but dropped to USD1,210/t in May. The price rise in Q1 was mainly influenced by the COVID-19 pandemic, as raw material supply was tight then due to impeded production, restricted transportation and lack of available labor resources. The AHF price followed the rising trend shown in prices of the raw materials. As domestic conditions eased, production gradually resumed and AHF supply recovered, so the price began to fall. In H2 2020, the price stayed at a low level and rebounded within a narrow range, reaching USD1,363/t in Dec. 2020. The price was affected by sluggish downstream demand, especially a weak demand from refrigerant industry.

In 2021, AHF price started from USD1,512/t in Jan. and climbed to USD2,103/t in Dec., up by 39.1%. Specifically:

● In Jan.–Feb.: AHF price increased, driven by a mismatch between supply and demand and the increasing price of raw material fluorite.

● In March–Aug.: AHF price fluctuated slightly, influenced either by cost or by demand.

● In Sept.–Dec.: The rose rapidly, and peaked at USD2,207/t in Nov., mainly because prices of both the upstream material fluorite and downstream refrigerants rose.

2022 saw ups and downs in AHF price, with the highest price at USD1892/t and the lowest of USD1566/t, specifically:

● In Jan.–May: AHF remained at a high level ranging from USD1864/t to USD1892/t. During this period, supply of AHF was sufficient but downstream demand was rather stagnant, resulting in the fluctuation of AHF price.

● In June–Oct.: AHF price fell significantly. The demand for refrigerants diminished terribly, which further dragged the price to the lowest point of the year to USD1566/t in Oct.

● In Nov.–Dec.: AHF price climbed back as the raw materials fluorite was in tight supply resulting from the low operating rate of producers.

In H1 2023, the overall AHF price continued the downward trend, with the highest seen in Jan. and the lowest in May.

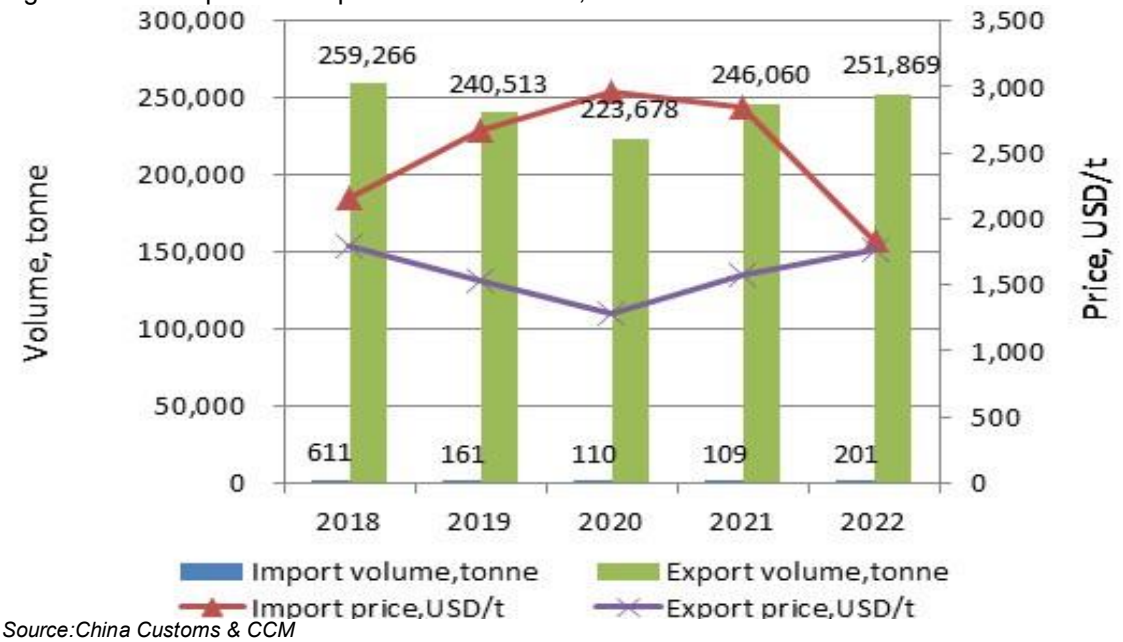
Figure 3.2.2-1 Monthly ex-works price of AHF in China, Jan. 2018–June 2023

Source: CCM

3.2.3 Import and export

China's AHF import volume remained at a low level. As to exports, the volume fluctuated in a flat "V" shape in 2018–2022. The export volume reached 259,266 tonnes in 2018, the highest in the next five years while 2020 saw the lowest volume of 223,768 tonnes and in years after 2020, export volume gradually rebounded and in 2022 reached 251,869 tonnes.

Figure 3.2.3-1 Import and export of AHF in China, 2018–2022



Source:China Customs & CCM

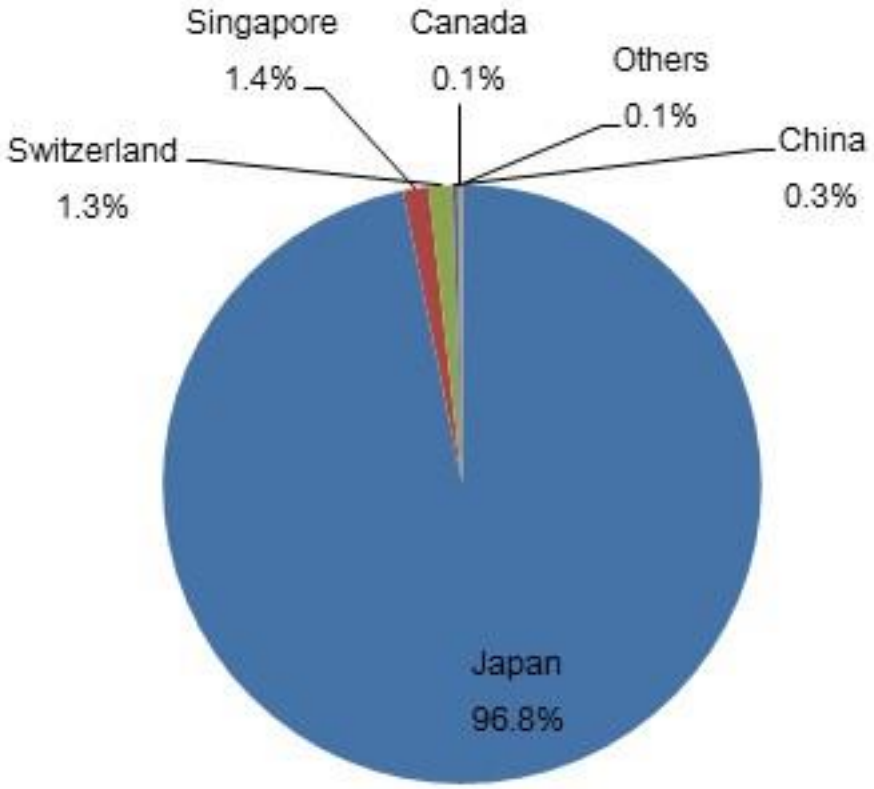
Table 3.2.3-1 Imports and exports of AHF in China, 2018–2022

Year	Import			Export		
	Volume, tonne	Value, USD	Price, USD/t	Volume, tonne	Value, USD	Price, USD/t
2018	611	1,316,003	2,155	259,266	463,492,030	1,788
2019	161	429,883	2,666	240,513	369,441,548	1,536
2020	110	325,255	2,957	223,678	288,553,356	1,290
2021	109	309,241	2,847	246,060	388,422,726	1,579
2022	201	370,555	1,844	251,869	443,861,892	1,762

Source:China Customs & CCM

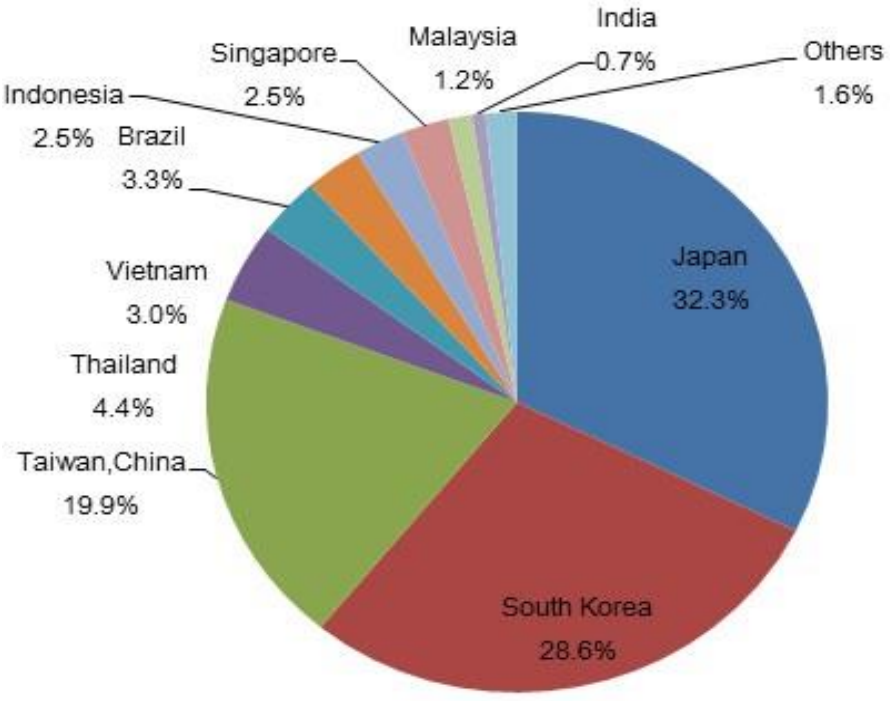
The main export destinations of China in 2022 lies in Asian countries and regions. In 2022, Japan was the largest export destination for China's AHF, followed by South Korea, Taiwan of China, and Thailand. Meanwhile, Japan was also the largest source of AHF imports into China, accounting for 96.8% of total imports.

Figure 3.2.3-2 Top import origins of AHF to China by volume, 2022



Source:China Customs & CCM

Figure 3.2.3-3 Top ten export destinations of AHF from China by volume, 2022



Source:China Customs & CCM

3.2.4 Future trends

AHF is vital to the development of fluorine industry. In the next few years, the development of AHF industry will be decided by the following three factors:

- Transformation and upgrading

Under the strict environmental protection policies and supervision, enterprises in pursuit of capacity expansion must first upgrade production process, optimize devices, or further develop and utilize low-quality fluorine-containing resources to achieve transformation and upgrading.

- Raw materials
In recent years, China has had greater control over strategic resources and curbed ill-planned or unplanned exploitation of fluorite resources at home. The cost of obtaining mining rights and fluorite resources exploitation will be on the rise.

- Demand from related industries
The demand for AHF will be bolstered by improved demand from the downstream sectors like organic fluorine industry, inorganic fluorides, high-energy battery materials and semiconductors, and even AI.

The price of AHF is usually affected by supply and price of its raw material fluorite. Driven by growing demand and tightening supply of fluorite, the price of AHF is expected to fluctuate at a high level in the future.

Currently, some Chinese enterprises have ongoing AHF capacity expansion projects, and it is expected that China's AHF capacity will increase in the next two to three years.

Table 3.2.4-1 List of projects expected to be built up and operate in the near future

No.	Enterprise	Expansion, t/a	Expected finish time
1	E.Redox Chemicals Co., Ltd.	20,000	2023
2	Jiangxi Xingfu Zhonglan New Material Co., Ltd.	120,000	2023
3	Ulanqab Yingke Technology Development Co., Ltd.	50,000	2023
4	Jinchang Shuangyi Chemical Technology Co., Ltd.	30,000	2023
5	Fujian Wengfu Lantian Fluorchem Co., Ltd.	10,000	2023
6	Yichang New Yangfeng FERTILIZER Co., Ltd.	80,000	2024
7	Jiangxi Xingfu Zhonglan New Material Co., Ltd.	70,000	2024
8	Quzhou NGF Chemical Co., Ltd.	40,000	2024
9	Guizhou Chanhen Chemical Corporation	30,000	2024
10	Yunnan Wengfu Yuntianhua Fluorchem Technology Co., Ltd.	10,000	2024
11	Xinjiang Kexin New Chemical Materials Co., Ltd.	120,000	(Phase I) Aug. 2024
12	Zhejiang Sanmei Chemical Industry Co., Ltd.	159,000	2025
13	Guizhou Chanhen Chemical Corporation	30,000	2025
14	Xinjiang Qiangsheng New Materials Technology Co., Ltd.	100,000	-
15	Yunnan Wengfuxiang Fengfluorosilicone New Material Co., Ltd.	30,000	-

Source: CCM

3.3 Aluminum fluoride

At present, about 95% of the world's aluminum fluoride is used in the aluminum electrolysis industry as the adjusting agent of electrolyte and to replenish the consumption of aluminum fluoride in the molten solution of cryolite during electrolysis. In addition, part of the aluminum fluoride is also used as the flux for the outer

layer of ceramic glaze and enamel glaze.

3.3.1 Production situation

Aluminum fluoride is an important material used in electrolytic aluminum industry and nearly 90% of aluminum fluoride is used in this area.

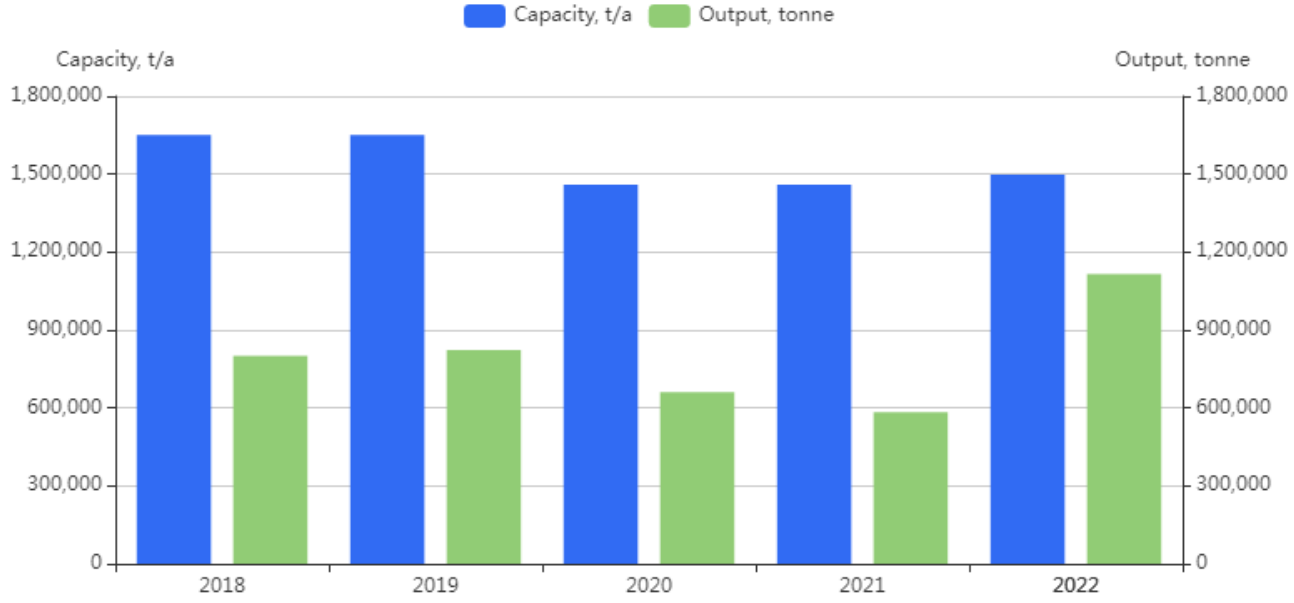
According to the China Inorganic Salt Industry Association, China's aluminum fluoride industry presents the following characteristics:

- The industry is in serious overcapacity, with large inventory and low operating rate;
- With improved aluminum fluoride quality, unit consumption of aluminum fluoride for electrolytic aluminum decreases.

As the largest aluminum fluoride provider in the world, China had 1,650,000 t/a capacity of aluminum fluoride in 2017–2019. However, the capacity decreased to 1,460,000 t/a in 2020–2021, as some manufacturers cut down their capacity or switched to AHF production.

In 2017–2019, the output of aluminum fluoride increased slightly, reaching 823,000 tonnes in 2019. Hit by the COVID-19 pandemic and the policy of de-inventory, operating rate of aluminum fluoride in China lowered in the past two years. As a result, China's aluminum fluoride output fell in 2020 and further decreased to 584,000 tonnes in 2021. In 2022, the output of aluminum fluoride increased significantly thanks to the rising demand in electrolytic aluminum industry.

Figure 3.3.1-1 Capacity and output of aluminum fluoride in China, 2018–2022



Source: CCM

In China, the production of aluminum fluoride is mainly concentrated in Henan Province and Shandong Province. Do-Fluoride Chemicals Co., Ltd. was the largest aluminum fluoride manufacturer in 2022, with a capacity of 330,000 t/a. However, it was reported by the company that the operating rate dropped to just 50% in 2022.

The second largest producer was Shandong Bofeng Lizhong Chemical Co., Ltd., with 90,000 t/a capacity, but its operating rate declined a lot in 2021, mainly affected by weak demand. Yizhang Hongyuan Chemical Co., Ltd. ranked third with 80,000 t/a capacity.

Table 3.3.1-1 Main active aluminum fluoride manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Do-Fluoride New Materials Co., Ltd.	Henan	330000	300,000	16,5000	146,400
2	Shandong Bofeng Lizhong Chemical Co., Ltd.	Shandong	90,000	90,000	/	7,000
3	Yizhang Hongyuan Chemical Co., Ltd.	Hunan	80,000	80,000	30,000	28,000
4	Jiaozuo Jinruida Aluminum Industry Co., Ltd.	Henan	78,000	78,000	55,380	36,000
5	Hunan Nonferrous Hengdong Fluorin Chemical Co., Ltd.	Hunan	70,000	70,000	/	37,000
6	Guangxi Pingguo Hetai Technology Co., Ltd.	Guangxi	60,000	60,000	42,600	35,000
7	Henan Zhongse Dongfang Shaoxing Industrial Co., Ltd.	Henan	60,000	60,000	40,000	32,000
8	Jiangxi Fufeng New Material Technology Co., Ltd.	Jiangxi	60,000	60,000	48,000	5,000
9	Shandong Zhaohe New Materials Technology Co., Ltd.	Shandong	45,000	45,000	30,000	21,000
10	Jinyang Advanced Materials Co., Ltd.	Anhui	40,000	40,000	21,700	16,000
11	Yunnan Yuntianhua Fluorine Chemical Co., Ltd.	Yunnan	43,000	35,000	31,300	23,000
12	Zhangye Sanyi Chemical & Trading Co., Ltd.	Gansu	30,000	30,000	21,300	18,000
13	Shaanxi Yanchang Petroleum Group Fluorosilicon Chemical Co., Ltd.	Shaanxi	30,000	30,000	18,000	15,000
14	Chengde Yingke Fine Chemical Co., Ltd.	Hebei	30,000	30,000	30,500	15,000
15	Zibo Nanhan Chemicals Co., Ltd.	Shandong	25,000	25,000	17,500	10,000
16	Jiaozuo Minli Industrial Co., Ltd.	Henan	10,000	10,000	7,000	6,000
Others			417,000	417,000	556,839	133,600
Total			**1,498,000**	**1,460,000**	**1115,119**	**584,000**

Source: CCM

3.3.2 Price

The price of aluminum fluoride mainly fluctuates along with the price of raw material AHF.

In 2017, the price kept going up; it began at USD1,006/t in Jan. and rocketed to USD1,918/t in Dec., up by 90.7%. Two big increases were seen: the first in Feb.–March, with the price up 15.31%, and the second in Oct.–Nov., up 26.66%. There were two main reasons for this surge: one was a supply shortage of aluminum fluoride in the market, and the other was the increasing price of upstream raw materials.

In 2018, a V shape can be identified in the price change. .At first, the price kept a downtrend in H1 and sank into a trough of USD1,410/t in July, mainly due to the glut in aluminum fluoride. But in H2, with shrinking aluminum fluoride inventories and rising raw material prices, the price of aluminum fluoride bounced back. Yet in 2019, the ex-works price of aluminum fluoride was on a general downward trend.

In 2020, China's aluminum fluoride price experienced two rounds of rising:

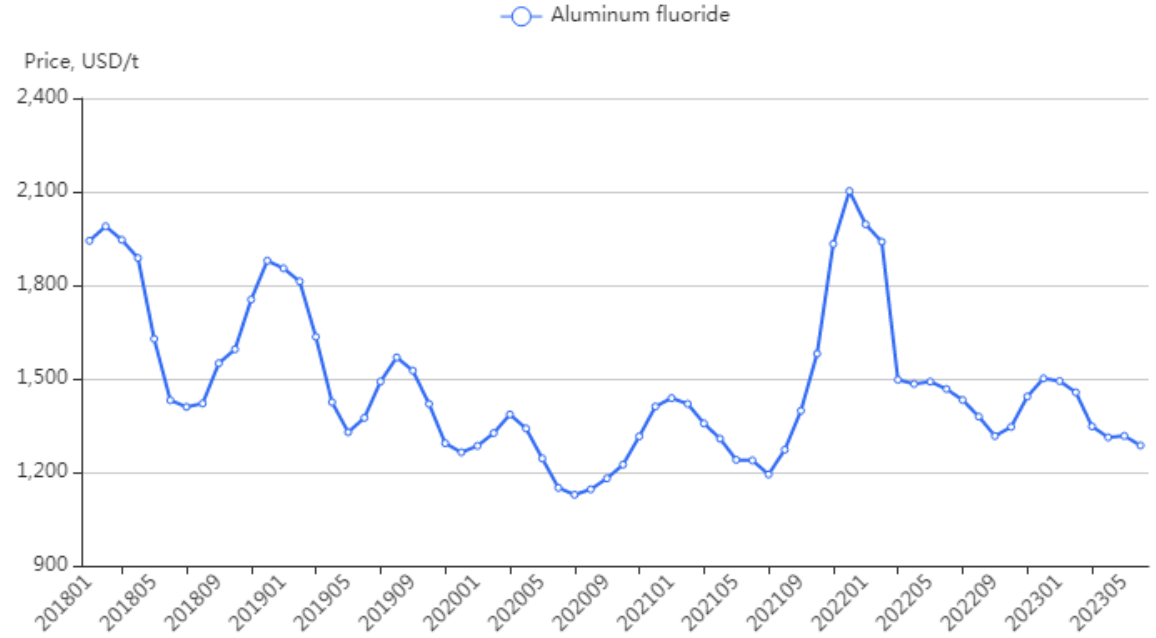
● Jan.–March: affected by the COVID-19 pandemic, downstream enterprises resumed production slowly, so the price of aluminum fluoride was at a low level compared with H1 2019. In March, the price climbed to USD1,385/t, the highest in this period. This peak came mainly due to tight raw material supply and thus higher cost, as well as blocked transportation in some parts of China.
● July–Dec.: aluminum fluoride price increased from USD1,128/t in July to USD1,411/t in Dec., driven by strong growth in downstream industries.

In 2021, aluminum fluoride price fell first and then shot up. In H1, the operating rate of the industry continued to run at a high level, and the inventories in manufacturers climbed. Consequently, the huge inventory dragged down the price of aluminum fluoride. However, the price trend reversed in H2. Supported by increasing costs and high downstream product prices, aluminum fluoride price soared and hit a high record in Dec. at USD2,102/t, up by 49.0% year on year.

In 2022, aluminum fluoride price fell rapidly in the first three months, then fluctuated at a rather low level and finally returned to an upward trend.
● In Jan.–March: The price of aluminum fluoride in the first month of 2022 was the highest price of the year, standing at USD1,995/t. In Q1, raw materials price fell dramatically, which pulled down the price of aluminum fluoride. Meanwhile, stable downstream demand couldn't give much support to the price.
● In April–Sept.: The price showed a downward trend and in Sept. saw the lowest price of the year at USD1,316/t. In this period, fluorite price was also in fluctuation and downstream demand for aluminum fluoride was rather sluggish.
● In Oct.–Dec.: The price started to increase. Nonetheless, even at the end of the year, the price was still far from the highest price of the year. In this period, Sichuan province issued power curb regulations and the production and supply of aluminum fluoride was thus impacted. But demand for aluminum fluoride couldn't meet expectations so downstream side wasn't able to give aluminum fluoride price long-term support.

In H1 2023, aluminum fluoride price saw a downward trend.

Figure 3.3.2-1 Monthly ex-works price of aluminum fluoride in China, Jan. 2018–June 2023



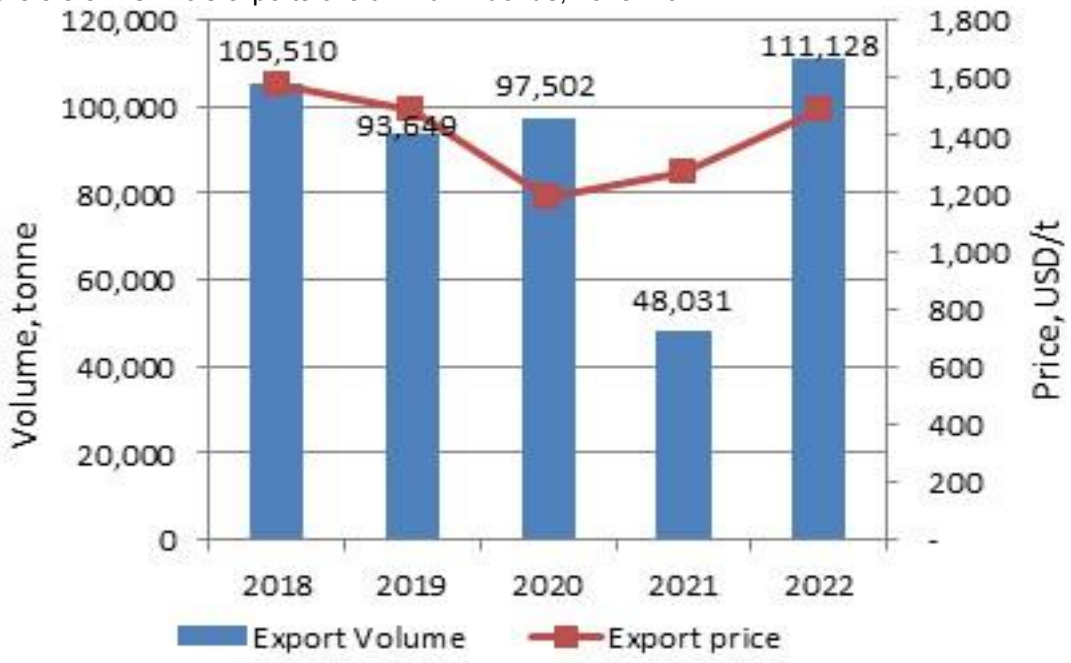
Source: CCM

3.3.3 Import and export

China's aluminum fluoride imports are still quite small and the exports remianed at a high level.
● From 2018 to 2022, China's export volume of aluminum fluoride kept fluctuated. Specifically, in 2020, due to the COVID–19 pandemic, overseas demand and domestic capacity declined.
● In 2021, with the outbreak still lingering globally, factories everywhere caught in repeated starts and stops. Therefore, the export volume hit the bottom during 2018–2022.
● Entering 2022, the impact of the epidemic gradually waned and production was being restored in China, while production in other countries remained very tight. As a result, exports reach a new high of

111,128 tonnes in 2022.

Figure 3.3.3-1 China's exports of aluminum fluoride, 2018–2022



Note:Anhydrous aluminum fluoride and other aluminum fluoride are included.
Source:China Customs & CCM

Table 3.3.3-1 China's imports and exports of aluminum fluoride (anhydrous), 2018–2022

Year	Import			Export		
	Volume, tonne	Value, USD	Price, USD/t	Volume, tonne	Value, USD	Price, USD/t
2018	155	1,315,414	8,491	104,816	165,792,535	1,582
2019	203	1,184,017	5,822	89,901	134,225,814	1,493
2020	163	1,183,366	7,264	86,284	103,083,351	1,195
2021	175	1,299,265	7,437	39,476	51,400,760	1,302
2022	233	1,554,748	6,672	105,187	157,121,943	1,494

Source:China Customs & CCM

Table 3.3.3-2 China's imports and exports of other aluminum fluoride, 2018–2022

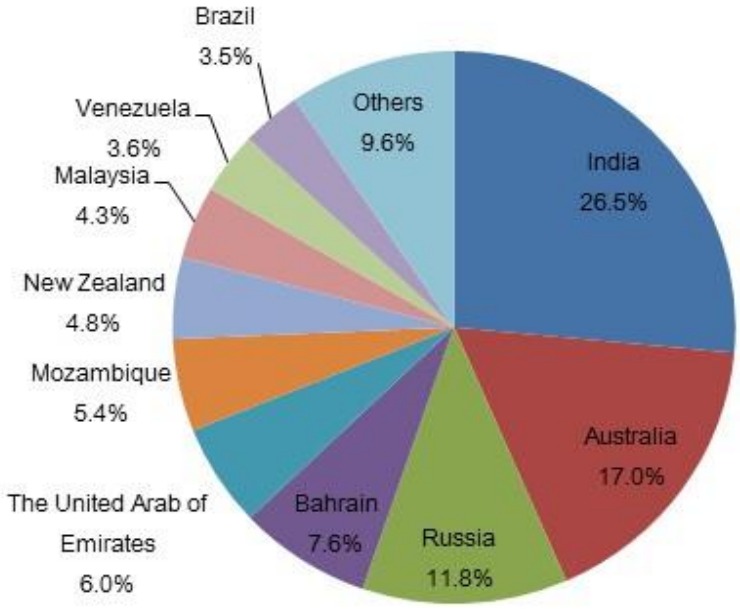
Year	Import			Export		
	Volume, tonne	Value, USD	Price, USD/t	Volume, tonne	Value, USD	Price, USD/t
2018	40	42,764	1,069	694	823,097	1,186
2019	2	3,577	1,807	3,748	4,971,569	1,326
2020	0	/	/	11,218	12,389,312	1,104
2021	0	/	/	8,555	9,883,848	1,155
2022	0.002	160	-	5,941	8,780,317	1,478

Source:China Customs & CCM

In 2022, China's aluminum fluoride was mainly exported to India, Australia, Russia and Bahrain; export volume of the top three destinations accounted for about 55.3% of the total.

In contrast, China's aluminum fluoride import was quite small and still mainly came from Sweden.

Figure 3.3.3-2 Top ten export destinations of aluminum fluoride from China by volume, 2022



Note:Anhydrous aluminum fluoride and other aluminum fluoride are included.
Source:China Customs & CCM

3.3.4 Future trends

The development of aluminum fluoride industry is closely linked to the development and prosperity of downstream industries such as electrolytic aluminum, abrasives, glass manufacturing, electronics.

Aluminum fluoride is an indispensable flux in the production of electrolytic aluminum. A healthy and sustainable development of the electrolytic aluminum industry will support the demand for aluminum fluoride. Given the policy restrictions to facilitate the supply-side reform and to achieve the Carbon peak and Carbon neutral goals, further expansion of electrolytic aluminum capacity will be suppressed. It is expected that the output of electrolytic aluminum will approach the upper limit, and the consumption of aluminum fluoride will also reach a peak.

Moreover, rapid development of abrasives, glass manufacturing, electronics and other industries provides new development space for the aluminum fluoride industry.

Overall, the demand for aluminum fluoride is expected to increase slightly in the coming years.

3.4 Cryolite

Cryolite is mainly used as a flux for aluminum electrolysis, as a wear-resistant filler for rubber and grinding wheels, and as a flux for ceramics and glass manufacturing. Cryolite is mainly divided into high polymer ratio cryolite and ordinary cryolite.

3.4.1 Production situation

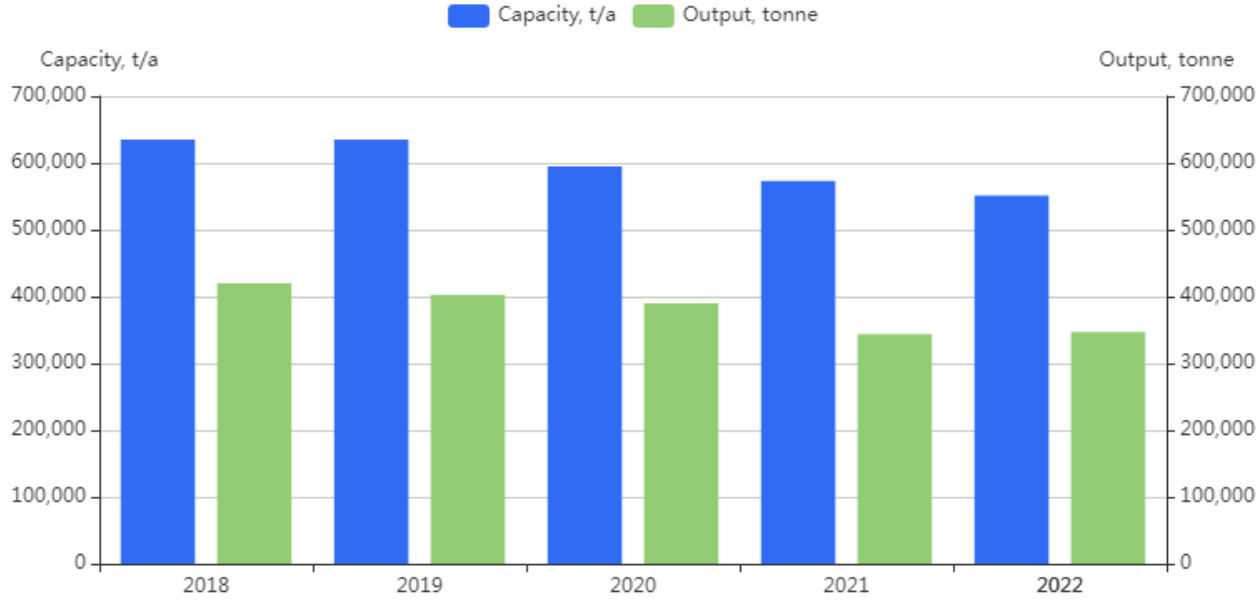
Most cryolite is consumed in the production of electrolytic aluminum, while a small part is consumed in welding electrodes, enamels and ceramics.

The rapid expansion of the scale of China's electrolytic aluminum industry has further stimulated the development of the cryolite industry. In 2017, after China issued the supply-side reform and actions to rectify illegal production capacity of electrolytic aluminum, the country began to limit new capacity of electrolytic

aluminum. Therefore, in recent years the capacity of cryolite has seen a downtrend. In 2022, the capacity of cryolite decreased to 551,000 tonnes, with a YoY decrease of 3.84%.

In the past five years, few manufacturers announced plans to expand production capacity, and some got out of the business. As a result, the capacity of cryolite in China decreased slightly from 665,000 t/a to 573,000 t/a in 2017–2021. At the same time, the output of cryolite dropped from 445,500 tonnes in 2017 to 343,800 tonnes in 2021, influenced by supply-side reform in electrolytic aluminum industry. Besides, new technologies of electrolytic aluminum production such as "use of electrolytes instead of cryolite" and "obtaining cryolite from aluminum electrolytic waste residue", have also contributed to the decrease. In 2022, capacity and output followed the downward trend to 551,000 tonnes and 347,130 tonnes respectively.

Figure 3.4.1-1 Capacity and output of cryolite in China, 2018–2022



Source: CCM

In China, the production of cryolite is mainly concentrated in Henan Province and Shandong Province, since electrolytic aluminum industry, which consumes the highest volume of cryolite, is more developed there.

Table 3.4.1-1 Main active manufacturers of cryolite in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Do-Fluoride New Materials Co., Ltd.	Henan	80,000	80,000	50,500	52,000
2	Shandong Bofeng Lizhong Chemical Co., Ltd.	Shandong	60,000	60,000	36,000	38,000
3	Zibo Kunyu Industry and Trading Co., Ltd.	Shandong	40,000	40,000	24,400	25,000
4	Zhuzhou Guangcheng Chemical Co., Ltd.	Hunan	30,000	30,000	19,500	22,000
5	Zhengzhou Tianrui Grain Technology Co., Ltd.	Henan	30,000	30,000	18,000	20,000
6	Fluorine Industry Enviromental Protection Technology (Yunnan) Co., Ltd.	Yunnan	30,000	30,000	18,000	20,000
7	Jiaozuo Jinkaiyuan Aluminum Co., Ltd.	Henan	/	30,000	/	18,000
8	Jiaozuo Minli Industrial Co., Ltd.	Henan	30,000	30,000	15,000	18,000

9	Shandong Rich Billows Group Limited	Shandong	20,000	20,000	15,000	17,000
10	Hunan Nonferrous Hengdong Fluoride Chemical Co., Ltd.	Hunan	20,000	20,000	12,000	13,000
11	Zhengzhou Hengtai Fluoride Salt Factory	Henan	20,000	20,000	12,000	12,000
12	Zibo Nanhan Chemical Co., Ltd.	Shandong	15,000	15,000	9,150	9,000
13	Changshu Hongjia Fluorine Technology Co., Ltd.	Jiangsu	15,000	15,000	9,000	8,500
14	Zibo Beidouxing Chemical Co., Ltd.	Shandong	10,000	10,000	7,000	8,000
15	Shandong Hairun New Material Technology Co., Ltd.	Shandong	10,000	10,000	6,000	6,000
16	Shaanxi Yanchang Petroleum Group Fluorosilicone Chemical Co., Ltd.	Shaanxi	5,000	5,000	2,500	2,500
17	Dazhou Lizhi Environmental Protection Technology Co., Ltd.	Sichuan	3,500	3,500	2,100	1,500
Others			132,500	124,500	90,980	53,300
Total			551,000	573,000	347,130	343,800

Source: CCM

3.4.2 Price

Cryolite and AHF prices displayed somewhat similar price fluctuations and trends.

In 2017, the price of cryolite soared. It was USD675/t in Jan. but ended at USD1,016/t in Dec., up by 50.7%.

In 2018, demand for cryolite was sluggish and the price was on a downward trend. It headed all the way south from USD1,050/t in Feb. to USD812/t in Oct. In 2019, though an overall weak operation was seen, the price of cryolite did not fluctuate much as the demand was also slack. The supply-demand balance continued in H1 2020 and the price fell within the range of USD761/t and USD787/t.

In 2022, cryolite prices experienced a fall and rise. In Jan.–March, the spring festival made a tight supply and raw materials price were also on the rise so the price were going upward. But in the next few months followed a series of price falls for that raw material costs were in fluctuation while going downward generally. In addition, downstream demand also couldn't give the price strong support. Since Oct., cryolite prices went up and then fluctuated at a high level until H1 2023.

Figure 3.4.2-1 Monthly ex-works price of cryolite in China, Jan. 2018–June 2023

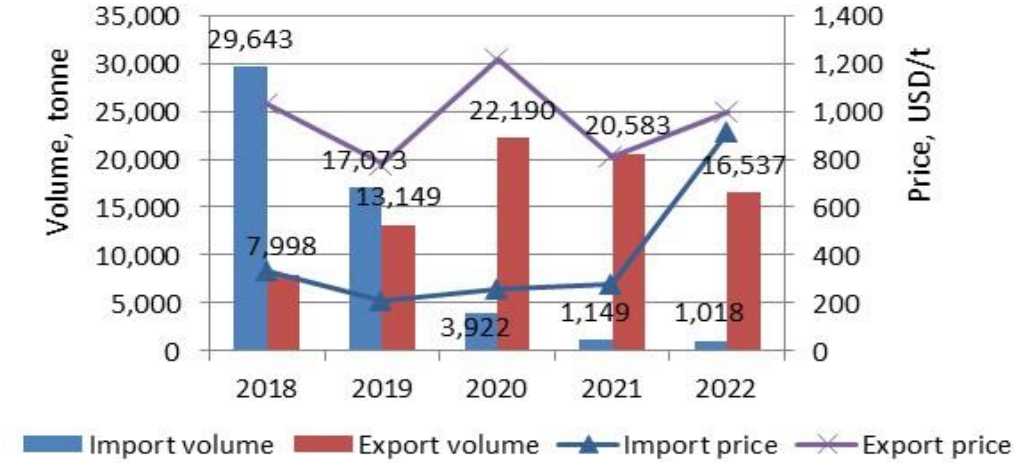
Source: CCM

3.4.3 Import and export

From 2018 to 2022, China's cryolite imports showed a sharp downward trend from a peak of 29,643 tonnes in 2018 to 1,018 tonnes in 2022, mainly due to the gradual maturation of the production technology of domestic cryolite producers, and that the quality of the products they produce can be comparable to that of foreign products.

Generally, China's Cryolite exports showed an uptrend in 2018–2020 from 7,998 tonnes to 22,190 tonnes. However, in 2021–2022, the COVID-19 pandemic hit most of the world and factories' production was unstable, there was a decline in cryolite exports.

Figure 3.4.3-1 Imports and exports of cryolite in China, 2018–2022



Source:China Customs & CCM

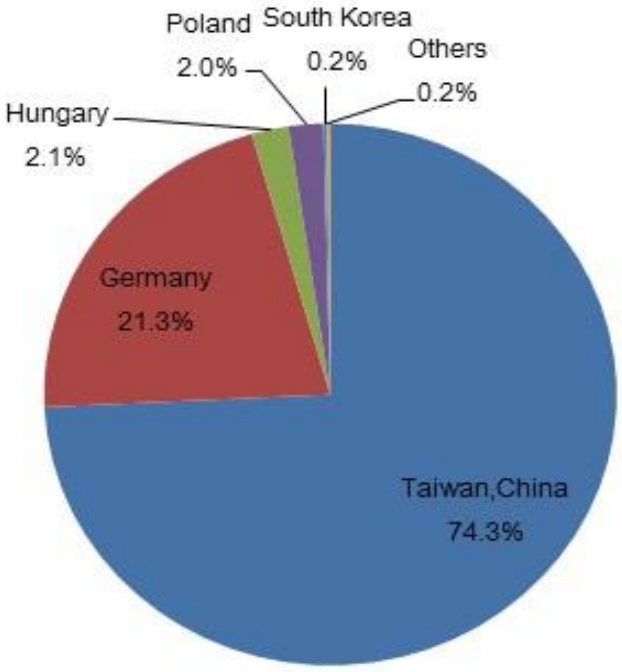
Table 3.4.3-1 Imports and exports of cryolite in China, 2018–2022

Year	Import			Export		
	Volume, tonne	Value, USD	Price, USD/t	Volume, tonne	Value, USD	Price, USD/t
2018	29,643	9,941,360	335	7,998	8,248,917	1,031

2019	17,073	3,589,543	210	13,149	10,253,044	780
2020	3,922	1,004,733	256	22,190	27,028,200	1,218
2021	1,149	323,334	281	20,583	16,689,242	811
2022	1,018	931,011	914	16,537	16,550,801	1,000

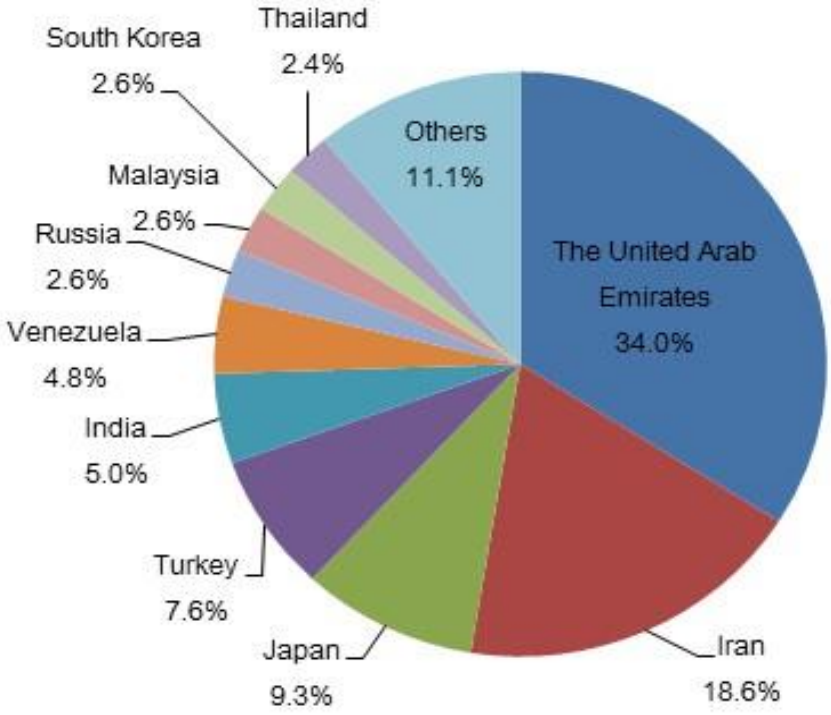
Source:China Customs & CCM

Figure 3.4.3-2 Top five import origins of cryolite in China by volume, 2022



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

Figure 3.4.3-3 Top ten export destinations of cryolite from China by volume, 2022



Source:China Customs & CCM

3.4.4 Future trends

Cryolite is mainly used as an auxiliary material in the production of electrolytic aluminum. Cryolite market relies highly on the development of China's aluminum industry. Due to supply-side reform in electrolytic aluminum industry, the capacity expansion of electrolytic aluminum has slowed down. Besides, further development of recycled electrolyte use in electrolysis process has weakened the demand for cryolite, and thus cryolite production will continue to decline.

3.5 Lithium hexafluorophosphate

Lithium-ion batteries mainly include power batteries, energy storage batteries and other products. Electrolyte, as the "blood" of lithium-ion batteries, is one of the key materials of lithium-ion batteries, playing a role in conducting lithium ions between the positive and negative electrodes of lithium-ion batteries. Lithium hexafluorophosphate is one of the best and most widely used lithium salt electrolytes.

3.5.1 Production situation

Lithium hexafluorophosphate ($LiPF_6$) is the main raw material for the manufacture of lithium-ion battery electrolytes. Because of its good ionic conductivity and electrochemical stability, it is currently the most commonly used electrolyte lithium salt.

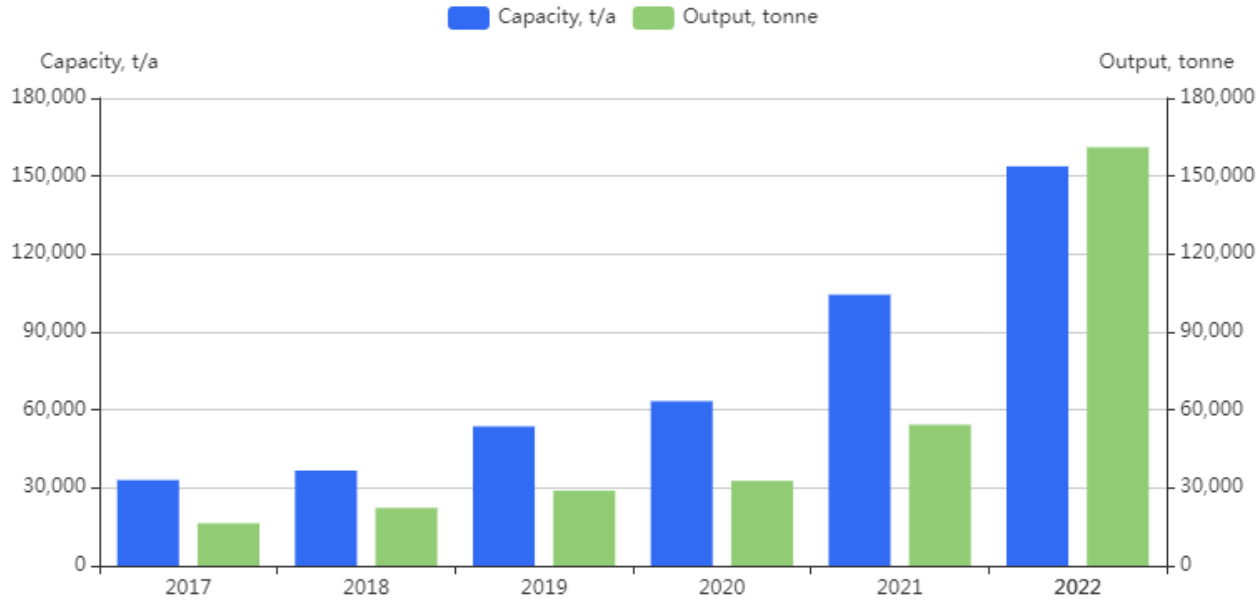
Along with the boom of lithium-ion battery industry, $LiPF_6$ also developed apace. In 2017–2021, both capacity and output of $LiPF_6$ in China increased. The capacity rocketed to 104,360 t/a in 2021 from 33,000 t/a in 2017, with a CAGR of 33.4%. The output increased steadily in 2017–2020 and witnessed a steep upward momentum in 2021, supported by demand from lithium-ion battery industry.

Since 2020, the supply of $LiPF_6$ in China lagged behind the demand, for the main reasons as follows:

- Surge in demand: as China introduced policies to encourage the development of new energy vehicles under the COVID-19 pandemic in H1 2020, large need for electrolytes in new energy vehicles industry brought a rapid surge in the demand for $LiPF_6$.
- Low operating rate: despite that capacity of $LiPF_6$ increased rapidly in 2020–2021, it took time for the release of the new capacity.

In 2022, the booming of NEV market led to a significant growth in the demand for raw materials of power batteries and major producers made expansions in both capacity and output to meet the needs of downstream market, which paved way for the overcapacity of $LiPF_6$ industry in 2023.

Figure 3.5.1-1 Capacity and output of $LiPF_6$ in China, 2018–2022



Source: CCM

In the last two years, many companies have expanded capacity. In 2022, there were eighteen major $LiPF_6$ manufacturers in China, and six of them had production capacity of more than 5,000 t/a. The output of $LiPF_6$

was mainly concentrated in top producers, mainly because these enterprises have large capacity, advanced technology, excellent product quality and stable customer base, which could prompt producers to gain more market share.

Table 3.5.1-1 Main active manufacturers of $LiPF_6$ in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Guangzhou Tinci Materials Technology Co., Ltd.	Guangdong	38,000	32,000	30,400	9,400
2	Do-Fluoride New Materials Co., Ltd.	Henan	55,000	20,000	48,400	16,100
3	Jiangsu Xintai Material Technology Co., Ltd.	Jiangsu	8,160	8,160	8,894	9,400
4	Zhejiang Yongtai Technology Co., Ltd.	Zhejiang	8,000	8,000	5,054	1,300
5	Morita new energy materials (Zhangjiagang) Co., Ltd.	Jiangsu	7,000	7,000	6,000	3,800
6	Jiangsu Jiujiujiu Technology Co., Ltd.	Jiangsu	6,400	6,400	6,793	5,400
7	Foosung Technologies (Nantong) Co., Ltd.	Jiangsu	5,200	3,800	4,160	1,200
8	Hubei Zhonglan Hongyuan New Energy Materials Co., Ltd.	Hubei	4,000	4,000	3,480	1,500
9	Fujian Longde New Energy Co., Ltd.	Fujian	3,000	3,000	1,000	800
10	Shandong Shida Shenghua Chemical Group Co., Ltd.	Shandong	2,000	2,000	1,060	1,100
11	Shanshan Advanced Materials (Quzhou) Co., Ltd.	Zhejiang	2,000	2,000	1,740	800
12	Qinghai JZY New Material Co., Ltd.	Qinghai	2,000	2,000	1,600	200
13	Quzhou Beidouxing New Chemical Materials Co., Ltd.	Zhejiang	1,300	1,300	1,040	1,200
14	Jiangxi Shilei Fluorine Materials Co., Ltd.	Jiangxi	1,200	1,200	800	500
15	Tianjin Jinniu Power Sources Material Co., Ltd.	Tianjin	1,000	1,000	870	500
16	Hubei Hongyuan Pharmaceutical Technology Co., Ltd.	Hubei	1,000	1,000	933	500
17	Befar Group Co., Ltd.	Shandong	1,000	1,000	1,040	400
18	Guangdong Jinguang High-Tech Co., Ltd.	Guangdong	500	500	400	200
Total			**146,760**	**104,360**	**123,664**	**54,300**

Source: CCM

Table 3.5.1-2 Production and share of top five $LiFP_6$ manufacturers in China, 2021–2022

Item	2022	2021	Share	
			2022	2021
Capacity, t/a	116,160	75,160	79.1%	72.0%
Output, tonne	100,487	44,100	81.3%	81.2%

Source: CCM

3.5.2 Price

Subject to the release of new capacity of $LiPF_6$ and slower growth in downstream demand, $LiPF_6$ price underwent a sharp correction in 2017. Specifically:

- Supply: new capacity of $LiPF_6$ released, which intensified competition among $LiPF_6$ enterprises.
- Demand: due to fewer subsidies in the new energy vehicle industry and the higher price for some raw materials of electrolytes, the demand for electrolytes from domestic lithium-ion battery decreased rapidly.

In 2018–H1 2020, $LiPF_6$ prices hit bottom and remained at a low level. $LiPF_6$ market was in a continued oversupply, sending the price of $LiPF_6$ to the bottom. The situation was hard to pick up, and continued until H1 2020.

In H2 2020–Feb. 2022, $LiPF_6$ price soared and peaked in Feb. 2022. This surge was backed by improvement in demand. Since H2 2020, the demand for new energy vehicles experienced explosive growth, resulting in a boost in lithium-ion battery demand. The strong growth of demand for $LiPF_6$ outran supply increase, and $LiPF_6$ industry entered a new boom cycle. As a result, the price of $LiPF_6$ continued to rise.

From March to June 2022, the price declined from the peak, mainly due to the suppression of downstream demand. Continuous high price of $LiPF_6$ dampened the purchasing desire in downstream enterprises, resulting in fewer new transactions. On the other hand, as some regions were hit by COVID-19 resurgences, downstream industry saw lower operating rates and thus lowered the consumption of $LiPF_6$. In addition, the release of new $LiPF_6$ capacity led to an increase in market supply, which also contributed to the decline in the price of $LiPF_6$.

In H1 2023, $LiPF_6$ fluctuated at a rather low level compared with the peak in Feb. 2022. It is predicted that the price will continue to fall in the long term.

Figure 3.5.2-1 Monthly ex-works price of $LiPF_6$ in China, Jan. 2018–June 2023

Source: CCM

3.5.3 Import and export

In 2018–2022, Chin's $LiPF_6$ export continued to grow, with the volume jumping from 3,053 tonnes to 17,608 tonnes. With the growth of global new energy vehicle industry, electrolyte demand rose. As a result, $LiPF_6$ as the raw material in eletrolyte of power battery saw a rapid increase in its price and capacity, and its export volume also climbed up.

$LiPF_6$ import volume was relatively small, because of high self-sufficiency of $LiPF_6$ in China. Especially in 2020, the import volume dropped to only about 1 tonne with the sweep of COVID-19 around the world.

Figure 3.5.3-1 Import and export of $LiPF_6$ in China, 2018–2022

Source:China Customs & CCM

Table 3.5.3-1 Imports and exports of $LiPF_6$ in China, 2018–2022

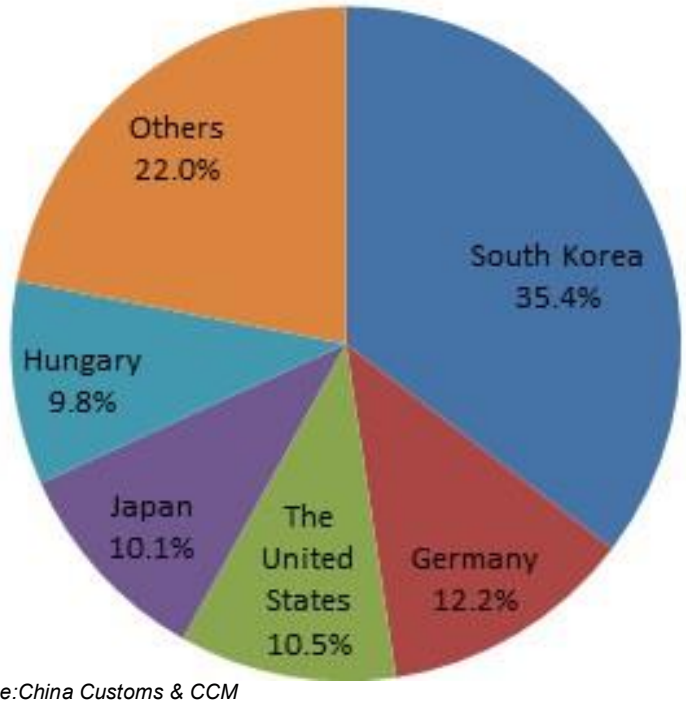
Year	Import			Export		
	Volume, tonne	Value, USD	Price, USD/t	Volume, tonne	Value, USD	Price, USD/t
2018	508	9,436,345	18,579	3,053	61,044,093	19,997
2019	386	7,161,616	18,530	4,558	73,317,505	16,085
2020	1	14,303	11,666	7,780	82,790,481	10,641
2021	589	15,336,601	26,019	13,051	240,227,139	18,407
2022	865	29,568,237	34,183	17,608	461,772,532	26,224

Source:China Customs

In 2022, China imported 865 tonnes $LiPF_6$. Main import origins were Japan and South Korea, which accounted for nearly 100% of the total imports (volume from other countries was only 0.003 tonnes).

South Korea, home to Li-ion battery giants such as LG and Samsung, was the largest destination for China's $LiPF_6$ exports, accounting for 35% of total exports, followed by Germany, the US, Japan and Hungary.

Figure 3.5.3-2 Top five export destinations of $LiPF_6$ from China by volume, 2022



Source:China Customs & CCM

3.5.4 Future trends

Increasing demand for lithium-ion battery from various sectors, including consumer electronics and automotive, is pushing the demand for $LiPF_6$. It is expected that the demand for lithium-ion battery will continue to increase in the coming five years, and $LiPF_6$, with huge market potential, will have its capacity exceed 500,000 t/a in China by 2025.

However, in the short term, the brutal expansion of $LiPF_6$ has driven down its price. At the same time, new LiPF6 production lines and producers are emerging, and even many fertilizer companies intend to expand LiPF6 business. In the future, LiPF6 industry will gradually enter the stage of overcapacity, and manufacturers with limited strength will be eliminated from the market.

Table 3.5.4-1 Capacity expansion of $LiPF_6$ in China in the near future

No.	Producer	Expanded capacity, t/a	Expected launch time
1	Guangzhou Tinci Materials Technology Co., Ltd.	97,000	2025
		200,000	N/A
2	Jiangsu Tairui Lianteng Material Technology Co., Ltd.	30,000	
			2025
3	Lizhong Sitong Light Alloys Group Co., Ltd.	18,000	
			2024
4	Zhejiang Yongtai Technology Co., Ltd.	20,000	2024
5	Fujian Longde New Energy Co., Ltd.	10,000	2024
6	Changshu Xinhua Chemical Co., Ltd.	10,000	2024
7	Jilin Chengtai New Material Co., Ltd.	10,000	2024

8	Fujian Qingliu Dongying Chemical Co., Ltd.	6,000	2024
9	China Kings Resources Group Co., Ltd.	25,000	N/A
10	Guangdong Jinguang High-Tech Co., Ltd.	10,000	N/A
11	Hubei Hongyuan Pharmaceutical Technology Co., Ltd.	6,000	N/A
12	Jiangxi Shilei Fluorine Materials Co., Ltd.	4,800	N/A
13	Qinghai JZY New Material Co., Ltd.	4,000	N/A
14	Shanshan Advanced Materials (Quzhou) Co., Ltd.	2,000	N/A
15	Quzhou Beidouxing New Chemical Materials CO., Ltd.	1,300	N/A
16	Guangxi Hetai Investment Group Co., Ltd.	10,000	N/A

Source: CCM

3.6 Others

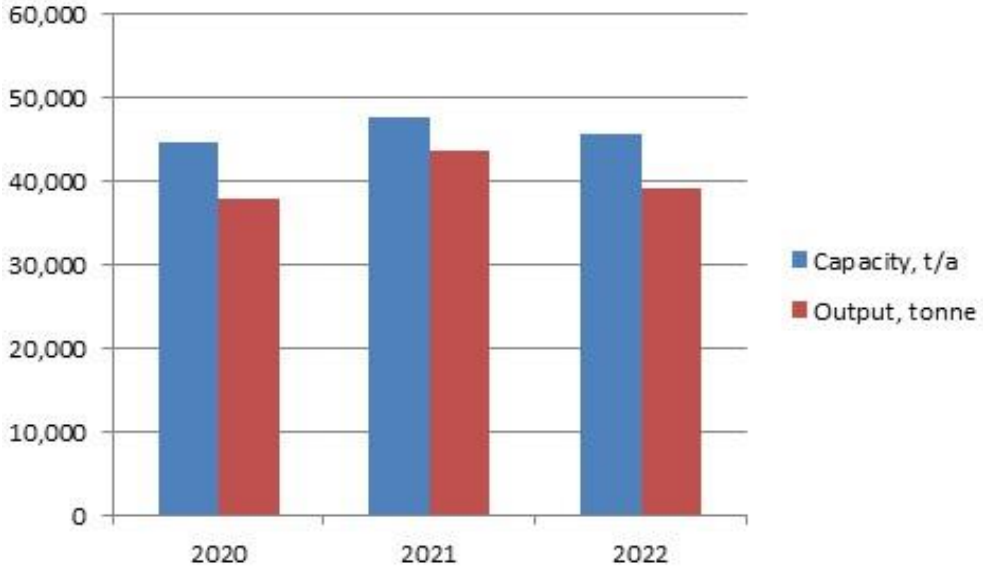
- Sulfur hexafluoride

As an important fluorinated gas, sulfur hexafluoride (SF_6) is widely used in power equipment, metal smelting, aviation, medical and other industries. It is also an ideal etching gas, mainly used in the manufacture of semiconductor devices, flat panels and photovoltaic panels.

As of 2021, there were about 12 SF_6 manufacturers in China. During 2019–2021, there was no new entrant in the industry, and some manufacturers quit the market. But the total capacity increased slightly from 45,700 t/a in 2019 to 47,700 t/a in 2021, after one manufacturer expanded its capacity.

In 2022, demand for electrical equipment grew.
However, companies with limited strength either lowered their output or were washed out under strict environmental protection policies, making the overall capacity and output of SF_6 in 2022 decrease.

Figure 3.6-1 Capacity and output of SF_6 in China, 2020–2022



Source: CCM

In China, capacity and output of SF_6 are mainly concentrated in some large companies, such as Chengdu Kemeite Special Gas Co., Ltd., Fujian Deer Technology Co., Ltd., Shandong Feiyuan Gas Co., Ltd., and Liming Research & Design Institute of Chemical Industry Co., Ltd.

Table 3.6-1 Main active SF_6manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Chengdu Kemeite Special Gas Co., Ltd.	Sichuan	22,000	22,000	17,600	20,000
2	Fujian Deer Technology Co., Ltd.	Fujian	7,000	10,000	5,665	8,850
3	Shandong Feiyuan Gas Co., Ltd.	Shandong	5,500	5,500	6,200	5,780
4	Liming Research & Design Institute of Chemical Industry Co., Ltd.	Henan	3,500	3,500	3,150	3,260
5	Shandong Ruihua Fluoride Industry Co., Ltd.	Shandong	2,500	2,500	2,350	2,050
6	Fujian Yongjing Technology Co., Ltd.	Fujian	1,600	1,600	1,500	1,450
7	Shouguang Longhao Chemical Co., Ltd.	Shandong	500	500	400	400
8	Xinxiang Lifan Fluoride Industry Co., Ltd.	Henan	500	500	400	450
Others			1,600	1,600	735	1,360
Total			**44,700**	**47,700**	**38,000**	**43,600**

Source: CCM

- Lithium bis(fluorosulfonyl)imide

Lithium bis(fluorosulfonyl)imide (LiFSI) can be used as an electrolyte additive for lithium-ion batteries and used in the electrolyte of rechargeable lithium-ion batteries.

LiFSI is a new type of lithium salt with excellent performance. Compared with $LiPF_6$, it has better electrochemical properties, hydrolysis resistance, thermal stability and electrical conductivity. It can also be used as an additive, or as an electrolyte individually. Therefore, LiFSI is expected to be the next generation major electrolyte in lithium-ion batteries taking the place of $LiPF_6$ and will have a very large market in the future.

Due to high technical barriers of LiFSI, only a few domestic manufacturers produce the product and the output is small. In 2020 and 2021, the output of LiFSI was 552 tonnes and 2,640 tonnes respectively. In 2022, as China's Li-ion battery indusrty heats up, a number of companies have expanded their production capacity and new producers are being evaluated by the authorities.

Table 3.6-2 Main active LiFSI manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Guangzhou Tinci Materials Technology Co., Ltd.	Guangdong	4300	2,300	3440	380
2	Shanghai Chemspec Corporation	Zhejiang	2800	200	2250	90
3	Do-Fluoride New Materials Co., Ltd.	Henan	2400	900	1680	450
4	Rolechem (Shandong) New Material Co., Ltd.	Shandong	1700	1,700	1,300	770
5	Zhejiang Yongtai Technology Co., Ltd.	Fujian	1600	1,600	1,120	410

6	Suzhou Fluolyte Co., Ltd.	Jiangsu	1000	1,000	700	400
7	Shenzhen Capchem Technology Co., Ltd.	Hunan	300	300	/	80
8	Jiangsu HSC New Energy Materials Co., Ltd.	Jiangsu	100	100	60	60
Total			**14,200**	**8,100**	**10,550**	**2,640**

Source: CCM

4 Organic fluorides in China

4.1 Fluorine refrigerants

Refrigerant is the working medium in refrigeration equipment, also known as refrigerating medium. Both heating and cooling refrigeration devices utilize the circular flow of refrigerant to finish the heat exchange, so refrigerant is an essential part of refrigeration equipment.

The global development of refrigeration can be divided into four stages:
1. From 1830 to 1930, heating and cooling refrigeration devices mainly adopted NH_3, CO_2, H_2O and SO_2 as refrigerants, the majority of which are out of use now for being poisonous, flammable or low efficient.

2. From 1930 to 1990, refrigeration devices mainly used CFCs, HCFCs and NH_3 as refrigerants. However, both CFCs and HCFCs pose threats to the ozone layer and have high GWP, so they are bound to be eliminated. CFCs are compounds consisting of chlorine, fluorine, and carbon atoms, which are very stable in the troposphere. They are degraded only in the stratosphere by the sun's radiation and then release chlorine, which contributes to ozone depletion. They can persist in the troposphere for 100 years or longer.

- CFCs are mainly used for refrigerants, foaming agents and cleaning agents.
- HCFCs are compounds comprising hydrogen, chlorine, fluorine, and carbon atoms. These compounds can be degraded naturally in the lower atmosphere and do not persist as long as CFCs. Only a fraction of HCFCs emitted can be transported to the ozone layer in the stratosphere where their chlorine could deplete ozone. The ODP of HCFCs accounts for only 2% to 11% of CFCs'. HCFCs are used for refrigerants, foaming agents, fire extinguishing agents, cleaning agents, aerosols and so on.

3. From 1990 to 2010, the main refrigerants were HFCs, with some HCFCs and HCs. HFCs are compounds consisting of hydrogen, fluorine, and carbon atoms, which can be used as refrigerants, foaming agents, fire extinguishing agents. Produced mostly in developed countries, HFCs replaced CFCs and HCFCs for they pose no harm to the ozone layer since they do not contain chlorine. However, some HFCs still generate greenhouse gases with a high GWP.

4. After 2010, because of global environmental requirements, the fourth generation of fluorinated refrigerant was put into market, which has low GWP and zero ODP. HFOs like R1234yf and R1234ze, close-to-natural refrigerants like propane (R290) and R161, natural refrigerants like CO_2 have been used.

China has been accelerating replacement of HCFCs, due to their high ODP, even though they are the dominant refrigerants in China. The elimination work is in the pipeline, which, of course, will greatly affect refrigerant industry in China.

In order to achieve phase-out plan of HCFCs, China implements quota management system for the production and consumption of some specific HCFCs. Since 2013, the Ministry of Ecology and Environment of the People's Republic of China (MEE) has published production quota and internal production quota for each manufacturer of HCFCs, and use quota for each downstream enterprise every year. Specifically, for every manufacturer of HCFCs, production quota puts a cap on its total sales volume; internal production quota defines the maximum sales volume to other domestic enterprises. As to each downstream enterprise, its HCFCs consumption cannot exceed the company-specific use quota.

In April 2013, the 69th Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol approved the *HCFC Production Phase-out Management Plan* submitted by China. According to the plan, China shall achieve the target to freeze the production and consumption of HCFCs used in ODS field in 2013 respectively and cut 10% of the baseline in 2015. On 1 Jan., 2016, the capacity and output of HCFCs in China should be frozen at the average in 2015. HCFCs will be banned from 1 Jan., 2040.

At present, main fluorine refrigerants in China are difluorochloromethane (R22), 1,1,1,2-tetrafluoroethane (R134a), difluoromethane (R32), pentafluoroethane (R125), and R410a. Among them, R22 is one of the HCFCs, while R134a, R32, R125 and R410a are HFCs. Although HFCs do not destroy the ozone layer, they still have a significant greenhouse effect. In the short term, the phase-out of HFCs requires cost and market considerations. But in the long term, in the context of carbon neutrality, the environmentally friendly fourth-generation refrigerants will certainly replace the existing HCFC and HFCs.

4.1.1 R22

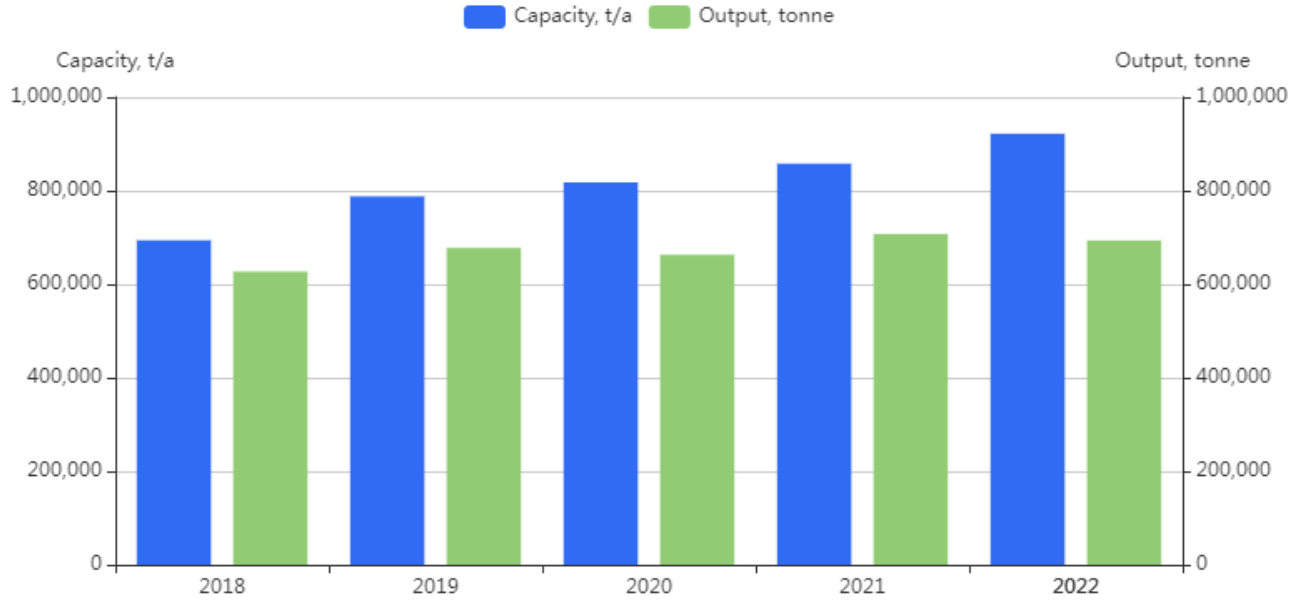
4.1.1.1 Production situation

R22 is one of the major fluorine refrigerants in China.

Although the production quota of R22 as refrigerant is reduced, the production of R22 used as a raw material is not restricted. Therefore, the reduction of R22 in ODS use can be offset by the increase in raw material use. In China, both the capacity and output of R22 used in raw material field have been on the rise with the capacity expansion of products such as PTFE and HFP.

The capacity of R22 continued to go upwards, to 857,900 t/a in 2021 from 693,900 t/a in 2017, with a CAGR of 5.4% in this period. As for output, from 2017 to 2019, the output of R22 grew along with increasing domestic demand in non-ODS field. However, influenced by the COVID-19 in 2020, the output of R22 shrank by 2.2% from the year before. As China's economy recovered in 2021, increasing domestic demand pushed up R22 output. In 2022, demand in the non-ODS field rose, but R22 output declined slightly, mainly due to tight controls in the refrigerant sector.

Figure 4.1.1.1-1 Capacity and output of R22 in China, 2018–2022



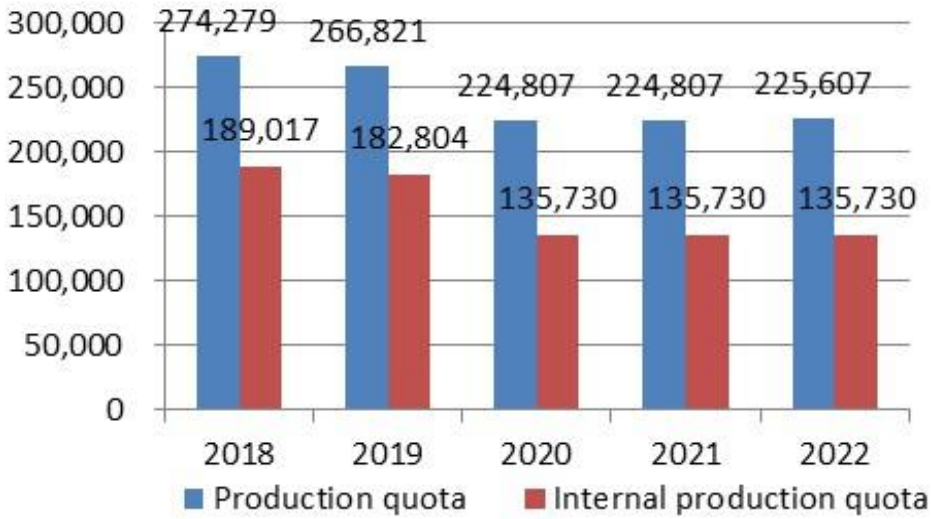
Note:1. The data of capacity and output in 2018–2019 have been revised. 2. The capacity and output include those R22 used in non-ODS field.
Source:MEE & CCM

China has signed all agreements to the Montreal Protocol. Under the protocol, China implements quota management of the production and consumption of R22 used in ODS field. For one thing, China strictly restricts new capacity increase. For another, the sales volume could not exceed the production quota; the sales volume to domestic enterprises could not exceed the internal production quota.

Under the Montreal Protocol, China agreed to keep the production and consumption of R22 at the average level in 2009–2010 by 2013, and reduce about 10% by 2015, 35% by 2020, 67.5% by 2025 and 97.5% by 2035, all based on 2013 level. So it is expected the supply of R22 for the ODS field will be tight in the future.

A decline is witnessed in the production quota of R22 given out by the Ministry of Ecology and Environment of the People's Republic of China (MEE), from 274,279 tonnes in 2017 to 224,807 tonnes in 2021, at a CAGR of -4.9%. In 2022, the production quota rose slightly.

Figure 4.1.1.1-2 Production quota of R22 in China, 2018–2022



Note:The internal production quota is part of production quota, which defines the maximum sales volume to other domestic enterprises.
Source:MEE

In China, the capacity and output of R22 are mainly concentrated in three large producers, namely Shandong Dongyue Chemical Co., Ltd., Zhejiang Juhua Co., Ltd. and Meilan Chemical Group Co., Ltd. Their R22 capacity and output combined accounted for about 60.0% and 61.9% of China's totals respectively in 2021.

In particular, Dongyue Group Ltd. is the largest R22 producer in China, with capacity and output of 220,000 t/a and 190,000 tonnes respectively in 2021. The company, having formed a complete fluorine industrial chain, is capable of not only self-supporting some raw materials for R22 like hydrogen fluoride and chloroform, but also participating in PTFE manufacturing with self-provided R22.

Table 4.1.1.1-1 Active R22 manufacturers in China, 2021–2022

No.	Producer	Location	2022				2021			
			Capacity, t/a	Output, tonne	Production quota, tonne	Internal production quota, tonne	Capacity, t/a	Output, tonne	Production quota, tonne	Internal production quota, tonne
1	Dongyue Group Ltd.	Shandong	220,000	198,000	66,228	37,670	220,000	190,000	66,228	37,670
2	Zhejiang Juhua Co., Ltd.	Zhejiang	183,000	136,400	58,682	42,457	183,000	152,500	58,682	42,457
3	Meilan Chemical Group Co., Ltd.	Jiangsu	112000	96,000	46,484	33,327	112,000	95,200	46,484	33,327
4	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	99,000	79,200	4,856	3,661	55,000	44,000	4,856	3,661
5	Fujian Sannong New Materials Co., Ltd.	Fujian	48,000	/	/	/	48,000	41,300	/	/

6	Changshu 3F Zhonghao New Chemical Materials Co., Ltd.	Jiangsu	40000	36,000	10,660	4,916	40,000	39,000	10,660	4,916
7	Zhonghao Chenguang Research Institute of Chemical Industry Co., Ltd.	Sichuan	38,000	26,600	0	0	38,000	36,500	0	0
8	Arkema (Changshu) Fluorochemical Co., Ltd.	Jiangsu	35,000	30,000	13,245	1,051	35,000	35,000	13,245	1,051
9	Linhai Limin Chemicals Co., Ltd.	Zhejiang	32500	26,000	10,158	4,980	32,500	23,000	10,158	4,980
10	Jiangxi Lee & Man Chemical Co., Ltd.	Jiangxi	60,000	42,000	/	/	60,000	25,000	/	/
11	Zhejiang Sanmei Chemical Co., Ltd.	Zhejiang	14,400	14,306	13,633	6,523	14,400	14,000	12,833	6,523
12	Zhejiang Pengyou Chemical Co., Ltd.	Zhejiang	10000	9,000	1,661	1,145	10,000	9,900	1,661	1,145
13	Jiangxi Zhongfu Chemical Material Technology Co., Ltd.	Jiangxi	10,000	/	/	/	10,000	2,100	/	/
Total			**921,900**	**693,506**	**225,607**	**135,730**	**857,900**	**707,500**	**224,807**	**135,730**

Note:1. The data of Zhejiang Juhua Co., Ltd., Zhejiang Sanmei Chemical Co., Ltd. and Zhejiang Yonghe Refrigerant Co., Ltd. include its subsidiaries. 2. Including those R22 used in non-ODS field.
Source:MEE & CCM

4.1.1.2 Price

In Jan. 2017–Nov. 2018, the ex-works price rocketed to USD3,395/t from USD1,433/t. Here are the reasons:

- Rigorous environmental inspections throughout China forced many small- or medium-sized companies to suspend production. Consequently, the remaining large refrigerant manufacturers had the upper hand and quoted higher prices.
- Great efforts were taken to avoid pollution of hydrofluoric acid and hydrochloric acid, driving up production cost.
- The strong demand from the air conditioner market also boosted the price.

In 2019, R22 price edged down, mainly due to weak support of raw materials and sluggish downstream demand.

In 2020, the price of R22 slightly fluctuated, owing to the significant reduction of production quota and the continuous COVID-19 epidemic at home and abroad. Specifically:

- In Q1, the price remained stable after rising, as the prices of raw material AHF and chloroform were quite stable. At the same time, affected by the COVID-19 outbreak, production resumption was delayed, and transportation control was severe. As a result, the market supply was tight, supporting the price of R22.
- In Q2, R22 price dropped, affected by the decline in raw material AHF price and weak demand home and abroad.
- In Q3–Q4, prices fluctuated slightly with changes in demand.

In 2021, R22 price went up wildly in general.

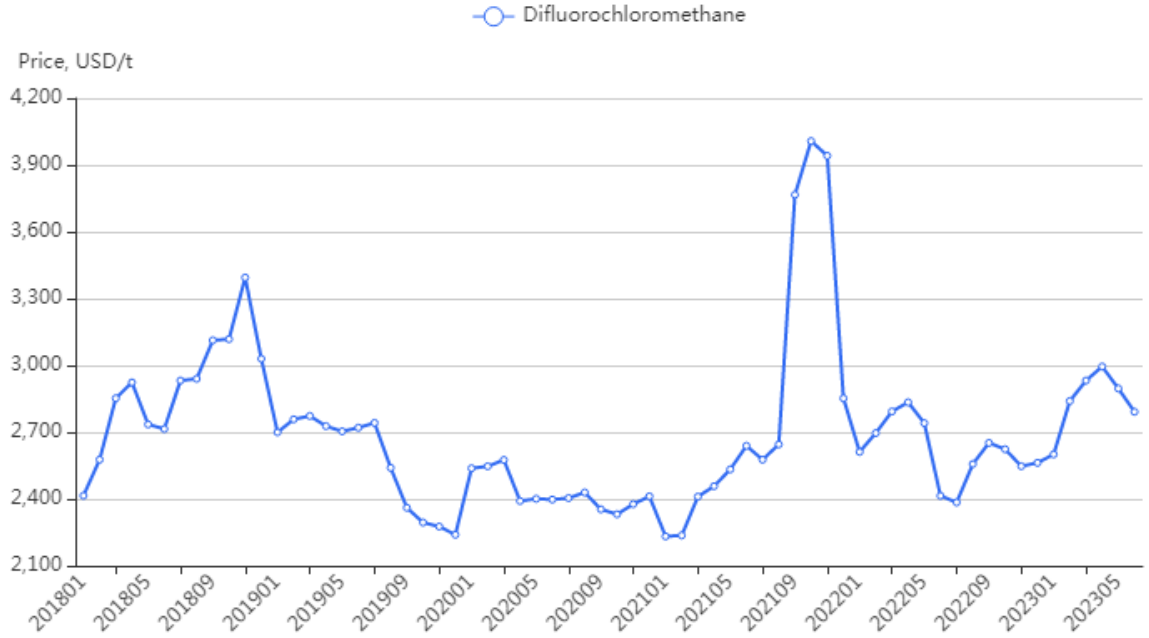
- In Q1, the price was at a low level. It edged up in March, driven by the high production cost and growing demand.
- In Q2, the price continued to rise, as the price of its raw material chloroform remained high.
- In Q3, it shot up in Sept. Two reasons led to the big increase. On the one hand, chloroform price

soared, forming a strong support for R22. On the other hand, the market supply was tight, due to the impact of production quota. Thus, R22 producers or dealers were reluctant to sell.
● In Q4, it fell in Dec. from the high levels in Oct. and Nov., affected by reduced demand and weak cost support.

In 2022, R22 price had gone through increase and decrease.
● In Q1, the price gradually grew mainly because of the tight supply and the stable demand.
● In Q2, R22 price during this period went down as raw material fluorite price continued to droped even though the burning weather had pushed up refrigerants demand.
● In Q3, after touching the ground price, it started to climb back as the result of the
● stable
● downstream demand and the
● overall increase
● of cost of production.
● In Q4, lower downstream demand during the off-season dragged the price down.

In H1 2023, within the range of USD2601/t–USD2995/t, R22 price rose at a rapid pace then dropped since April.

Figure 4.1.1.2-1 Ex-works price of R22 in China, Jan. 2018–June 2023

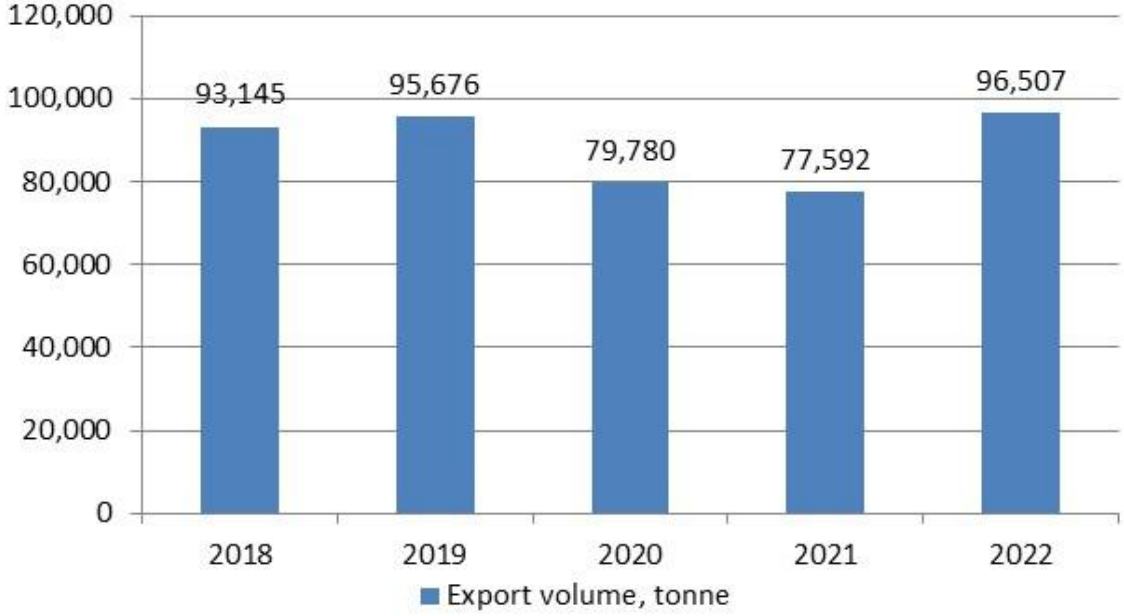


Source: CCM

4.1.1.3 Export

In 2018–2022, China's R22 export volume fluctuated. In 2022, after declining for three consecutive years, the export volume rebounded and reached a new high of 96,507 tonnes in the last five years.

Figure 4.1.1.3-1 Export volume of R22 in China, 2018–2022



Source:China Customs & CCM

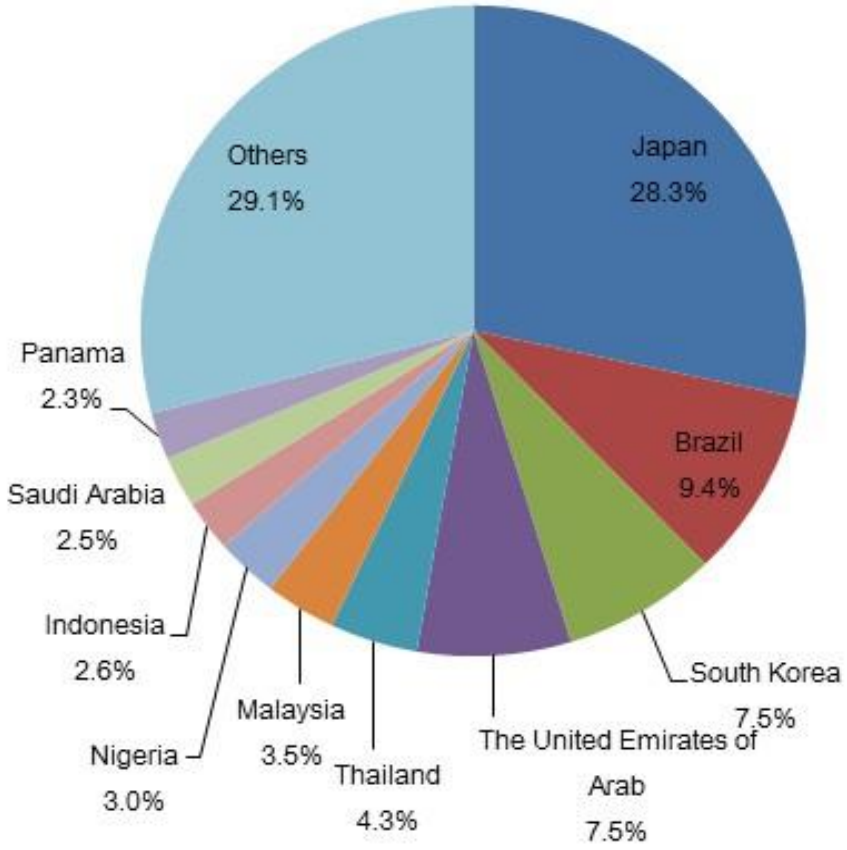
Table 4.1.1.3-1 Exports of R22 in China, 2018–2022

Year	Export volume, tonne	Export value, USD	Export price, USD/t
2018	93,145	233,785,964	2,510
2019	95,676	207,045,761	2,164
2020	79,780	125,362,839	1,571
2021	77,592	173,264,882	2,233
2022	96,507	241,230,186	2,500

Source:China Customs & CCM

In 2022, Japan, Brazil, South Korea and Thailand were the top four export destinations of R22 from China by volume, with combined export volume of 47,790 tonnes, about 53% of the total export volume.

Figure 4.1.1.3-2 Top ten export destinations of R22 from China by volume, 2022



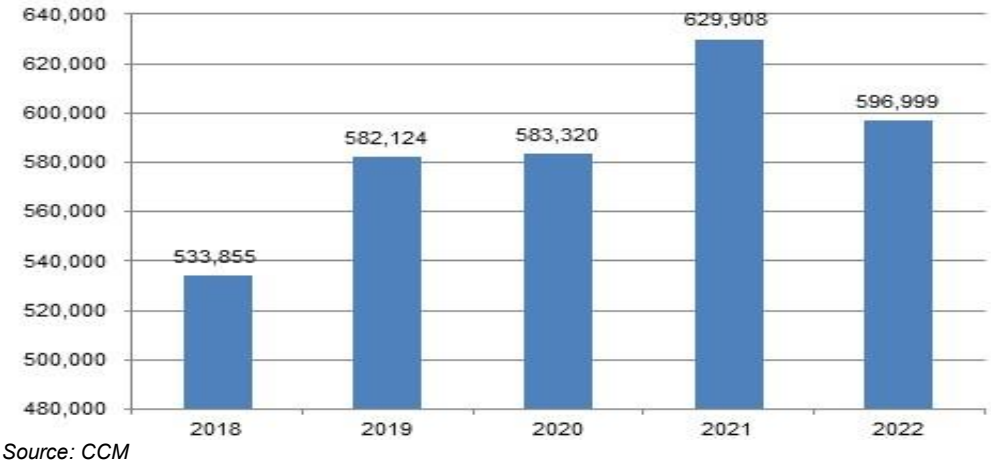
Source:China Customs & CCM

4.1.1.4 Consumption

R22 is the most widely used low-temperature refrigerant in China, mainly used as air conditioner refrigerant. It is also used in producing non-ODS products such as tetrafluoroethylene (TFE). TFE is an important raw material for R125, polytetrafluoroethylene (PTFE), HFP and so on.

In China, the apparent consumption volume of R22 was on the rise in 2017–2021. The consumption increase was attributed mainly to a rising downstream demand. In 2022, the tightening of environmental protection policies has led to refrigerant and air-conditioning manufacturers switching to other refrigerants, and the continuous decline in R22 prices also made downstream buyers cautious. Therefore, the consumption experienced a decline.

Figure 4.1.1.4-1 Apparent consumption of R22 in China, 2018–2022



Source: CCM

Since it has been planned to phase out R22 as an air conditioning refrigerant, its application narrowed rapidly during 2017–2021; its consumption volume in air conditioning refrigerant kept dropping. But its consumption in non-ODS sector witnessed a surge during the same period, thanks to high demand from the downstream sectors such as PTFE and HFP, keeping the total consumption of R22 from a significant decrease. On the contrary, the total amount showed an increase in 2017–2021. In 2022, the consumption dropped.

Table 4.1.1.4-1 Consumption of R22 in non-ODS field in China, 2018–2022

Year	Consumption volume, tonne
2018	344,838
2019	399,320
2020	447,590
2021	494,178
2022	461,269

Source: CCM

Table 4.1.1.4-2 Consumption quota of R22 in ODS field in China, 2018–2022

Year	Consumption quota, tonne			
	Room air conditioner	Industrial and commercial refrigeration and air conditioning	Extrude polystyrene foam	Others
2018	47,501	7,870	2,002	131,644
2019	48,941	7,425	1,278	125,160
2020	35,215	5,885	1,419	93,211
2021	31,726	5,959	1,175	96,870
2022	29,589	6,311	1,104	98,726

Source:MEE & CCM

Table 4.1.1.4-3 R22 quota allocation for room air conditioner industry, 2022

Company	Use quota, tonne	Percentage
Gree Group	11,452	38.7%
Media Group	7,245	24.5%
TCL Group	2,251	7.6%
Haier Group	2,048	6.9%
Zhigao Group	1,500	5.1%
AUX Group	1,170	4.0%
Galanz Group	1,774	6.0%
Haixin Group	600	2.0%

Others	1,549	5.2%
Total	**29,589**	**/**

Source:MEE

Table 4.1.1.4-4 R22 quota allocation for refrigeration and air conditioning in industrial and commercial application, 2022

Company	Use quota, tonne	Percentage
Gree Group	2,334	37.0%
Media Group	1,800	28.5%
Haier Group	777	12.3%
Others	1,400	22.2%
Total	**6,311**	**/**

Source:MEE

4.1.1.5 Future trends

Responding to the Montreal Protocol, the pace of worldwide HCFCs elimination has been stepped up. Developed countries have nearly completed the task, much ahead of developing countries. As one of the largest developing countries, China plays an important role in the work because its production and consumption of HCFCs account for the largest share of the world's totals.

In China, although R22 is still one of the main refrigerants, it will be gradually replaced by other eco-friendly refrigerants such as R134a, R410a etc., and its demand will decrease. However, as a raw material for the production of PTFE, HFP and other new refrigerants, R22's output is expected to keep increasing.

To sum up, the production quota of R22 as a refrigerant will gradually decrease in the next few years, and more and more downstream manufacturers will have to switch to its substitutes. However, it is predicted that the total consumption of R22 may rise rather than fall, bolstered by the demand from downstream sectors including PTFE and HFP.

4.1.2 R134a

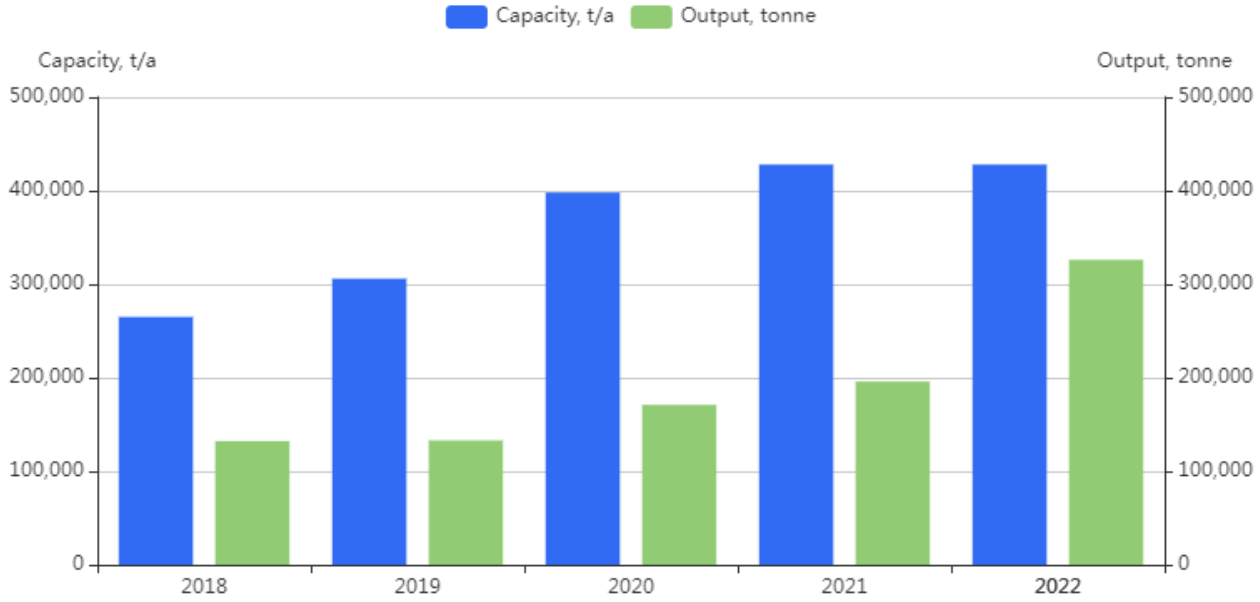
4.1.2.1 Production situation

The refrigerant market in China is in the phase of replacing the second-generation refrigerant products with third-generation products. Since 2019, manufacturers have begun to expand the capacity of third-generation refrigerants to grab more market share.

R134a does not destroy the ozone layer, so it is an environment-friendly refrigerant recognized and recommended for use, and a mainstream third-generation refrigerant in China.

In China, R134a capacity increased from 243,000 t/a in 2017 to 428,000 t/a in 2021, at a CAGR of 15.2%. The output stayed around 135,000 tonnes in 2017–2019, as its high price makes it difficult to promote its use in China. However, the output increased significantly in 2021–2022.

Figure 4.1.2.1-1 Capacity and output of R134a in China, 2018–2022



Note:The capacity in 2019 has been revised.
Source: CCM

In 2021, twelve manufacturers were reported to produce R134a in China. Zhejiang Province is the largest production region, accounting for 53.8% of the domestic output in 2021. The top three manufacturers were Zhejiang Juhua Co., Ltd., Zhejiang Sanmei Chemical Industry Co., Ltd. and Inner Mongolia Yonghe Fluorochemical Co., Ltd. Their combined capacity and output accounted for 42.8% and 61.6% of the total respectively.

In 2022, there were no new R134a production lines in China in 2022, but a significant increase was seen in the output as major producers increase production to win more HFCS quotations for 2023; in addition, rising downstream demand also contributed to the growth.

Table 4.1.2.1-1 Active R134a manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Zhejiang Juhua Co., Ltd.	Zhejiang	68,000	68,000	65,000	61,200
2	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	65,000	65,000	49,000	44,300
3	Inner Mongolia Yonghe Fluorochemical Co., Ltd.	Inner Mongolia	50,000	50,000	39,400	15,200
4	Sinochem Modern Environmental Protection Chemicals (Xi'an) Co., Ltd.	Shaanxi	40,000	40,000	30,000	14,000
5	Jiangsu Bluestar Green Technology Co., Ltd.	Jiangsu	40,000	40,000	25,000	11,000
6	Meilan Chemical Group Co., Ltd.	Jiangsu	30,000	30,000	23,000	11,000
7	Shandong Hua'an New Material Co., Ltd.	Shandong	30,000	30,000	20,000	9,000
8	Zibo Feiyuan Chemical Co., Ltd.	Shandong	30,000	30,000	23,700	7,500
9	Shaanxi Sinochem Lantian Chemical Technology New Material Co., Ltd.	Shaanxi	30,000	30,000	21,000	5,000

10	Jiangxi Zhongxin Artsen New Materials Co., Ltd.	Jiangxi	20,000	20,000	10,000	6,000
11	Dongyue Group Ltd.	Shandong	15,000	15,000	13,500	8,000
12	Ruyuan Dongyangguang Fluorine Co., Ltd.	Guangdong	10,000	10,000	6,500	3,800
Total			**428,000**	**428,000**	**326,100**	**196,000**

Source: CCM

4.1.2.2 Price

Influenced by the sharp increase in the prices of fluorite and AHF from 2017, the price of R134a increased from USD2,902/t in Jan. 2017 to USD5,736/t in April 2018.

As prices rose, R134a producers scrambled to expand supply and continued to raise the operating rates. Subsequently, there was an oversupply and the price of R134a fell sharply. Meanwhile, the fall in AHF prices further dragged the price of R134a down to USD2,846/t in Dec. 2019.

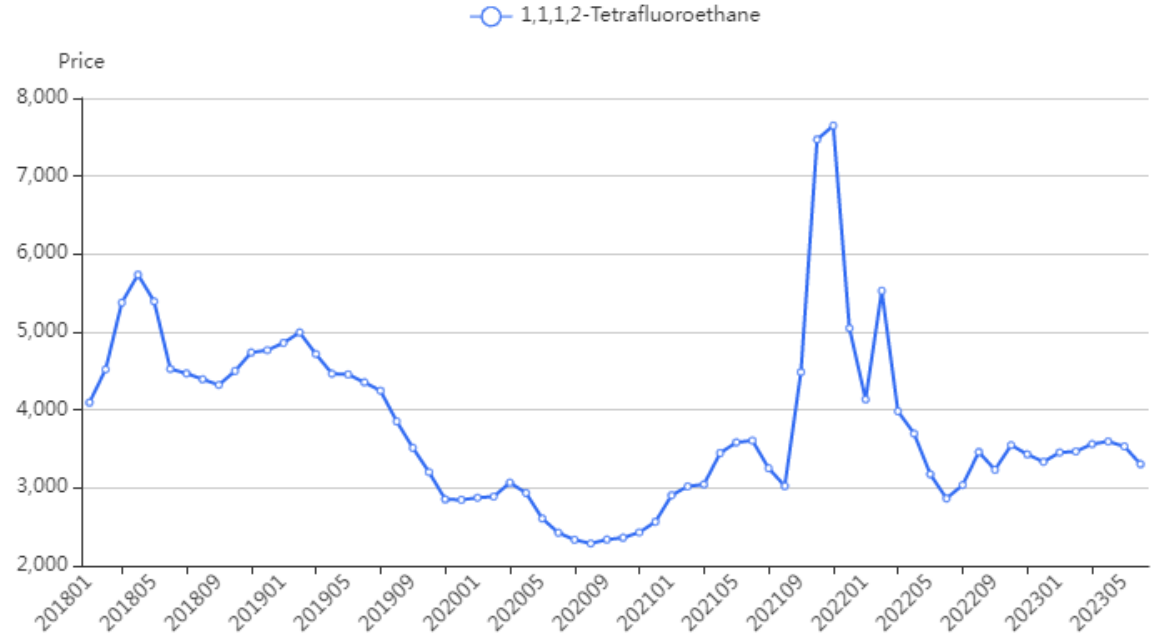
In 2020, R134a price was at a low level. From Jan. to March, the price followed the rising trend of its raw material AHF. However, starting from April, the price went down continuously due to the lack of cost support, this situation continued into Aug. In Sept., the price rose, driven by increasing price of the raw material trichloroethylene, and from then on it set on a recovery trajectory.

R134a price rose steadily in H1 2021, and during Sept.–Nov. it skyrocketed under the influence of tight power supply and the pressure of dual control of energy consumption. In Nov., the price reached a record high in the past five years, landing at USD7,647/t. Yet without support from costs and demand, the price fell sharply to USD5,048/t in Dec., with a month-on-month decrease of 34.0%.

In 2022, R134a price in general showed a downward trend. Despite a brief surge in Feb., the price returned to the downward trend soon and fluctuated at a low level of around USD3,400/t due to weak cost support and sluggish downstream demand.

In H1 2023, R134a displayed a stable price, while the price generally showed a declining trend as raw materials price fell, but the support of downstream demand will keep R134a price from plummeting.

Figure 4.1.2.2-1 Ex-works price of R134a in China, Jan. 2018–June 2023



Source: CCM

4.1.2.3 Future trends

It is expected that the use of HFCs will increase. The reason is that the trend of replacing HCFCs with HFCs cannot be reversed. More and more air conditioner manufacturers have to switch to HFCs.

However, we must be alert to the risks of the overcapacity of R134a, because demand for R134a has slowed in China as well as in overseas market. As a greenhouse gas, R134a's GWP is 1,300, which exceeds the amount allowed to be used in automobile air conditioners prescribed by the EU. Many countries gradually ban R134a as a refrigerant for automotive air conditioning. As a result, sales expansion of R134a faces difficulties worldwide.

It is reported that in Europe, a directive on MACs had stipulated that automobile air conditioners should not use refrigerants whose GWP exceeds 150, including R134a, from 1 Jan., 2017. At the end of 2016, the United States Environmental Protection Agency (USEPA) said it would ban the use of R134a in some products from 1 Jan., 2021. Consequently, some foreign manufacturers have stopped the production of R134a, and began to produce the fourth generation refrigerant R1234yf to replace R134a.

But for China, the substitution of R134a will take a long time because R134a is still one of the major refrigerants and only a few companies produce HFOs due to the cost of production.

4.1.3 R32, R125 and R410a

4.1.3.1 Production situation

- R32

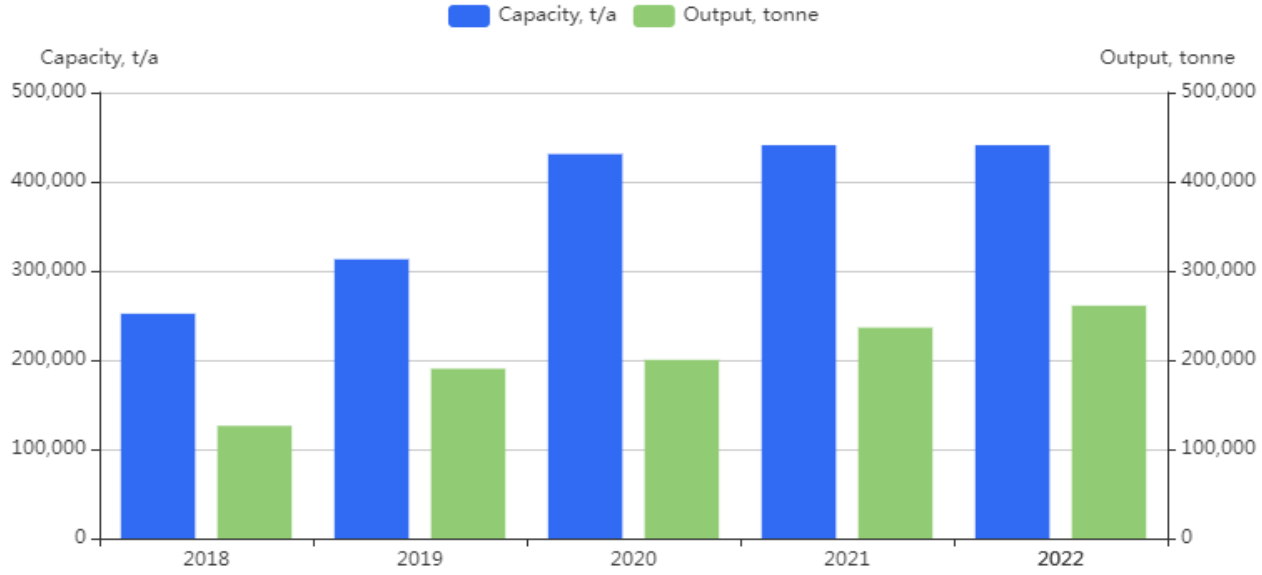
R32 is a substitute for R22. Being one of the major refrigerants in China, R32 is mainly used as an air conditioner refrigerant and a raw material for R410a.

In recent years, the structure of refrigerant use in domestic air conditioning industry has changed significantly. Driven by market and policy trends, the share taken up by R32 refrigerant has rapidly enlarged.

In China, R32 capacity and output increased at a CAGR of 19.0% and 15.5% respectively during 2017–2021. Since 2019, most of R32 manufacturers expanded capacity and actively improved sales to get larger production quota after 2024. Thus, the capacity and output increased significantly in 2020. In 2021, although the output of R32 continued to grow, the capacity remained basically unchanged as most of the expansion projects were completed before 2021.

In 2022, in the absence of new capacity coming on stream, strong players increased production, while producers with limited strength were hesitant to expand.

Figure 4.1.3.1-1 Capacity and output of R32 in China, 2018–2022



Source: CCM

In 2017, among all the domestic air conditioner manufacturers, only Gree Electric Appliances Inc. of Zhuhai (Gree) officially launched the air conditioners with R32. Demand for R32 from air conditioner industry accounted for only 6% to 10% of the output of R32. However, the market share of R32 in air conditioners has achieved a significant increase since 2019, as the share of R22 in the air conditioning sector dwindled.

In 2021, major R32 producers mainly concentrated in Shandong and Zhejiang provinces, and their combined capacity and output of R32 accounted for 75.5% and 80.8% respectively of the totals in China.

In 2022, Zhejiang Juhua Co., Ltd. was the largest R32 producer in China, with the capacity and output of 100,000 t/a and 84,000 tonnes, accounting for 22.7% and 32.2% of the domestic totals respectively. Dongyue Group Ltd. came in second.

Table 4.1.3.1-1 Main active R32 manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Zhejiang Juhua Co., Ltd.	Zhejiang	100,000	100,000	84,000	80,900
2	Dongyue Group Ltd.	Shandong	60,000	60,000	51,000	41,000
3	Meilan Chemical Group Co., Ltd.	Jiangsu	50,000	50,000	10,000	7,000
4	Shandong Hua'an New Material Co., Ltd.	Shandong	50,000	50,000	5,000	5,500
5	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	40,000	40,000	31,600	26,500
6	Ruyuan Dongyangguang Fluorine Co., Ltd.	Guangdong	30,000	30,000	25,000	25,300
7	Zibo Feiyuan Chemical Co., Ltd.	Shandong	30,000	30,000	20,000	18,000
8	Luxi Chemical Group Co., Ltd.	Shandong	10,000	10,000	7,000	7,000
9	Linhai Limin Chemicals Co., Ltd.	Zhejiang	10,000	10,000	10,000	7,000
10	Shanghai 3F New Materials Co., Ltd.	Shanghai	10,000	10,000	7,000	6,000
11	Jiangxi Lee & Man Chemical Co., Ltd.	Jiangxi	10,000	10,000	4,000	4,000
12	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	10,000	10,000	3,800	3,400
Others			31,000	31,000	2,600	4,800
Total			**441,000**	**441,000**	**261,000**	**236,400**

Note:1. The reason for Meilan Chemical Group Co., Ltd.'s low operating rate was that its subsidiary Taixing Meilan New Materials Co., Ltd. (with 40,000 t/a capacity) was still in trial production. 2. The reason for Shandong Hua'an New Material Co., Ltd.'s low operating rate was that the production line suspended for a long term.
Source: CCM

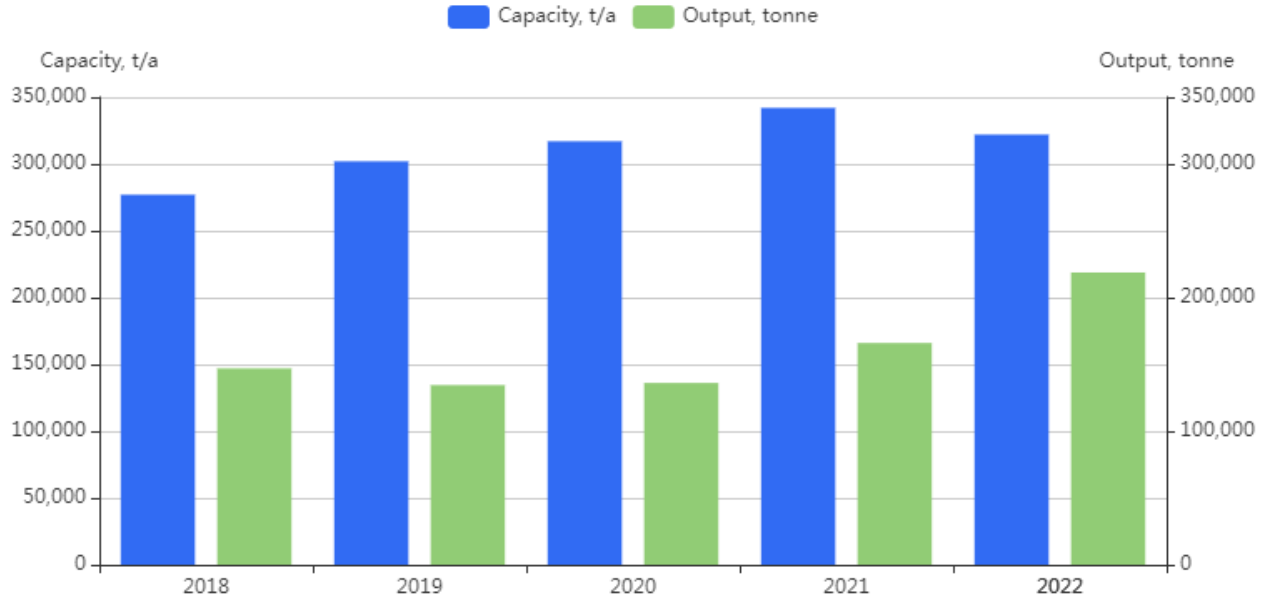
- R125

As a zero-ODP yet high-GWP refrigerant, R125 is mainly used to make R410a in China. According to the USEPA, its GWP is 3,450 times more than that of CO_2. It can also replace Halon-1211 and Halon-1301 as an extinguishing agent in the fire extinguishing system.

Like R32, R125 producers compete for production quota ahead of time by rapidly expanding capacity. As a consequence, R125 capacity grew steadily in 2017–2021, but the output fluctuated. In 2022, as Arkema Daikin Advanced Fluorochemicals (Changshu) Co., Ltd. deregistered, the total capacity dropped from

342,000 t/a in 2021 to 322,000 t/a; however, the output increased to 218,880 tonnes.

Figure 4.1.3.1-2 Capacity and output of R125 in China, 2018–2022



Source: CCM

In 2022, most R125 producers concentrated in Shandong and Zhejiang provinces; capacity in the two provinces made up 40.4% and 31.7% of the total in China respectively.

Dongyue Group Ltd. is the largest R125 producer in China, with the capacity and output of 58,000 t/a and 43,500 tonnes in 2022, accounting for 18.0% and 19.9% respectively of the domestic totals. Zhejiang Sanmei Chemical Industry Co., Ltd. is the second largest R125 producer in China; its capacity was 52,000 t/a and the output was 34,850 tonnes respectively in 2022. However, in terms of output, Zhejiang Juhua Co., Ltd. topped with 44,800 tonnes in 2022.

Table 4.1.3.1-2 Main active R125 manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Dongyue Group Ltd.	Shandong	58,000	58,000	43,500	14,500
2	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	52,000	52,000	34,850	32,700
3	Zhejiang Juhua Co., Ltd.	Zhejiang	50,000	50,000	44,800	43,600
4	Sinochem Environmental Protection Chemical Co., Ltd.	Jiangsu	30,000	30,000	9,000	9,000
5	Shandong Hua'an New Material Co., Ltd.	Shandong	30,000	30,000	15,000	9,400
6	Arkema Daikin Advanced Fluorochemicals (Changshu) Co., Ltd.	Jiangsu	/	20,000	/	7,000
7	Ruyuan Dongyangguang Fluorine Co., Ltd.	Guangdong	20,000	20,000	17,000	17,600
8	Zibo Feiyuan Chemical Co., Ltd.	Shandong	20,000	20,000	10,000	8,000
9	China Fluoro Technology Co., Ltd.	Shandong	20,000	20,000	10,000	6,000
10	Meilan Chemical Group Co., Ltd.	Jiangsu	10,000	10,000	8,000	6,000

11	Luxi Chemical Group Co., Ltd.	Shandong	10,000	10,000	6,000	4,000
Others			22,000	22,000	20,730	8,200
Total			**322,000**	**34,200**	**218,880**	**166,000**

Note:Arkema Daikin Advanced Fluorochemicals (Changshu) Co., Ltd. deregistered in 2022.
Source: CCM

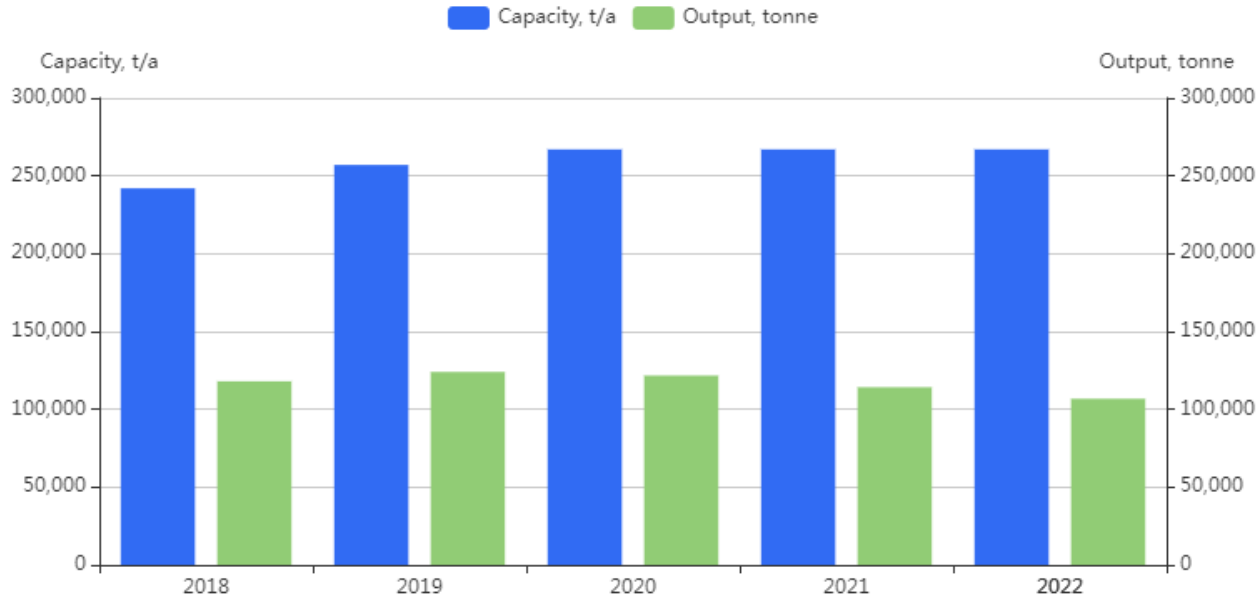
- R410a

R410a, a zero-ODP refrigerant made from 50% R32 and 50% R125, is widely used in the international market. It has high efficiency—the refrigerating effect of air conditioners with R410a is higher than that with R22. For example, based on a 2,500W air conditioner, the dosage of R22 is about 1.5 kg but that of R410a is about 1 kg. Therefore, R410a is recommended as the working medium in household air conditioners to replace R22.

However, R410a is not the best substitute for R22, as its high GWP brings about severe greenhouse effect. To protect the environment, R410a will be eliminated eventually.

The capacity of R410a increased slightly in China from 2017 to 2021, growing from 167,000 t/a to 267,000 t/a; especially in 2018, the capacity witnessed a steep upward momentum, mainly because of positive market expectations shared among manufacturers, who willingly enlarged their capacity to grab the new market. The output peaked at 124,000 tonnes in 2019, up by 5.1% year on year, as R410a was increasingly accepted by air conditioner manufacturers. Nevertheless, the output decreased in 2020–2021 due to the gradual implementation of the "double carbon" (carbon peaking and carbon neutrality) policy and the increasing requirements of environmental protection and energy efficiency. In 2022, output of R410a continued to decrease while major producers' output rose slightly as downstream demand still held up.

Figure 4.1.3.1-3 Capacity and output of R410a in China, 2018–2022



Source: CCM

Table 4.1.3.1-3 Main active R410a manufacturers in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Zhejiang Juhua Co., Ltd.	Zhejiang	50,000	50,000	26,000	25,000
2	Dongyue Group Ltd.	Shandong	50,000	50,000	21,000	20,000
3	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	30,000	30,000	7,500	7,000
4	Ruyuan Dongyangguang Fluorine Co., Ltd.	Guangdong	20,000	20,000	11,400	13,000
5	Luxi Chemical Group Co., Ltd.	Shandong	20,000	20,000	6,500	6,000
6	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	15,000	15,000	4,000	3,200
7	Meilan Chemical Group Co., Ltd.	Jiangsu	12,000	12,000	12,000	10,000
8	Zibo Feiyuan Chemical Co., Ltd.	Shandong	10,000	10,000	5,800	5,000
9	Shandong Hua'an New Material Co., Ltd.	Shandong	10,000	10,000	6,100	5,000
10	Linhai Limin Chemicals Co., Ltd.	Zhejiang	10,000	10,000	3,000	3,000
11	Shanghai 3F New Materials Co., Ltd.	Shanghai	5,000	5,000	2,300	2,000
Others			35,000	35,000	1,200	15,000
Total			**267,000**	**267,000**	**106,800**	**114,200**

Source: CCM

4.1.3.2 Price

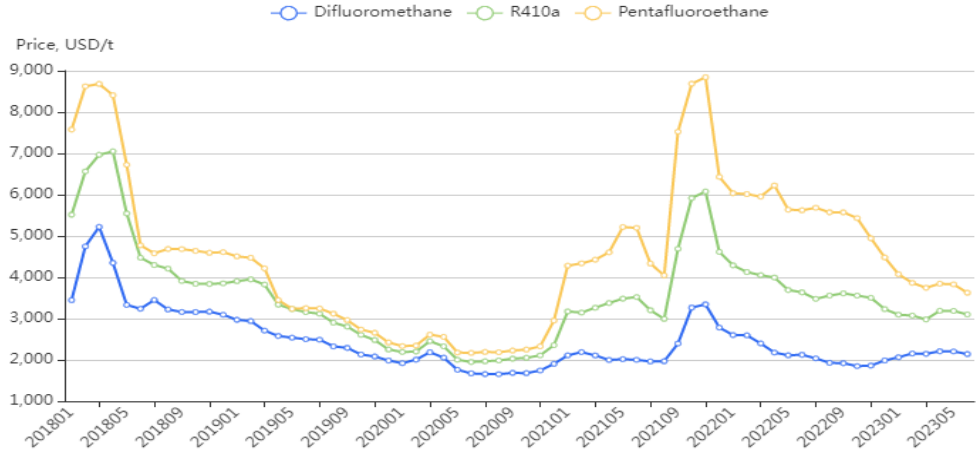
R410a is a mixture of R125 and R32. It is also an important refrigerant used in the home air-conditioning industry, and its price changes with the price of its raw materials.

The price of R410a dropped from USD7,049/t in April 2018 to USD2,252/t in Dec. 2019, which is due to the decrease in AHF price. Moreover, the production quota of R22 in 2019 did not cut much from the 2018 level, and the replacement of R22 by R410a did not progress as previously expected. Therefore, the price of R410a went down.

In 2020, the prices of three were at their lowest level in the past five years, affected by falling prices of raw materials and lack of demand from downstream industries.

In 2021–June 2022, given rapid changes in cost and demand, the prices of these three products fluctuated. In H2 2022, the three products in general remained stable. Among them, the R125 price dropped in line with the decline in raw materials, especially anhydrous hydrogen fluoride. In Q4 2022–Q1 2023, the R125 price rebounded slowly while the R32 price displayed a sharp decrease, making the price R410a fall slightly.

Figure 4.1.3.2-1 Ex-works price of R32, R125 and R410a in China, Jan. 2018–June 2023



Source: CCM

4.1.3.3 Future trends

Other than a small number of newly-produced air conditioners that still use R22, the third-generation refrigerant R410a or R32 is mainly used in China, and R410a is likely to be replaced by R32. Reasons are as follows:

- R410a is composed of R32 and R125, but its GWP and ODP are higher than R32.
- The price of R410a is higher than that of R32.
- The production cost of R410a air conditioner is higher than that of R32 air conditioner, and manufacturers and consumers are more inclined to choose R32 air conditioner.

It is expected that R32 will play the most important role in satisfying domestic demand for air conditioner refrigerants in China, while R410a will gradually see its share decrease. More R410a will go to export market in the next three years.

4.1.4 R1234yf

2,3,3,3-Tetrafluoropropene (R1234yf), is a hydrofluoroolefin with the formula CH_2=$CFCF_3$. It has been proposed as a replacement for R134a as a refrigerant in automobile air conditioners.

At present, R1234yf refrigerant has been vigorously promoted and applied in European Union (EU) and the US. Since core production technology patents of R1234yf refrigerant are monopolized by international companies such as Honeywell, Chemours, Arkema, Daikin, and Asahi Glass, there is high market concentration globally. Although other manufacturers claim to be able to produce R1234yf, Honeywell holds the most of the patents for R1234yf.

In China, R1234yf production is mainly licensed by international manufacturers. In 2022, there were five Chinese manufacturers that can produce R1234yf, with total capacity of 25,500 t/a. The 3,000 t/a R1234yf refrigerant project of Zhejiang Huanxin Fluoro Material Co., Ltd., with independent intellectual property rights was completed in Aug. 2022.

R1234yf is the latest substitute for R134a automotive refrigerant in EU and the US. Although the initial cost of the product is much higher than that of R134a, it has the lowest switching cost for automakers among the currently available alternatives.

However, in China, restricted by factors such as capacity and price, the application scale of R1234yf refrigerant is still relatively small. It is expect that the demand for R1234yf will continue to grow abroad as many countries gradually ban R134a as a refrigerant for automobile air conditioning. But the process may take years even decade to reach as China's output of HFCs will start to drop in 2024 and consumption will not be cut down until 2029.

Table 4.1.4-1 Situation of the production of R1234yf in China, 2022

No.	Producer	Location	Capacity, t/a	Source of technology
1	Zhejiang Juhua Co., Ltd.	Zhejiang	8,500	Honeywell
2	Changshu 3F Zhonghao New Chemical Materials Co., Ltd.	Jiangsu	6,000	Chemours
3	Lecron Industrial Development Group Co., Ltd.	Shandong	5,000	Independent R&D
4	Arkema (Changshu) Fluorochemical Co., Ltd.	Jiangsu	3,000	Arkema
5	Zhejiang Huanxin Fluoro Material Co., Ltd.	Zhejiang	3,000	Independent R&D

Source: CCM

4.2 Fluoride polymers

Fluoride polymer is the homopolymer or copolymer of monomers containing fluorine atoms. Because of its special structure, fluoride polymer obtains weatherability, hydrophobicity and lipophobicity, resistance to heat, acid, alkali, drug and tarnish, as well as excellent performance in viscosity, biological adaptability, gas permeability, radiation sensitivity and low friction coefficient, etc.

Since the fluoride polymers were introduced in 1960s, China has gradually become one of the largest fluoride polymer markets in the world. Supported by fast industry development and abundant fluorite resources in China, the fluoride polymer industry has developed rapidly. Fluoride polymer has also become one of the main exported fluoride products in China. And main products of fluoride polymers in China include PTFE, PVDF, FEP, PFA and ETFE.

PTFE is the principal product of fluoride polymers in China, followed by PVDF. China is weak in the production of functional fluoride polymers, especially high-end products. Also, processing equipment for fluoride polymers in China is inferior to that in most developed countries such as the US and Japan. Therefore, some high-end fluoride polymer products still need to be imported from developed countries which have advanced production technologies.

4.2.1 PTFE

At present, polytetrafluoroethylene (PTFE) is one of the most important fluoride polymer products, known as the "King of Plastics". It is a polymer polymerized by tetrafluoroethylene monomer, being transparent or opaque wax which is similar to PE. PTFE is resistant to acid, alkali and all kinds of organic solvents, almost insoluble in all solvents. In addition, the material has the following characteristics: high temperature resistance; very low coefficient of friction excellent electrical insulation performance, and can be continuously used at elevated temperatures.

With all the properties above, PTFE has served as vital materials in various industries such as chemistry, vehicles, medical treatment, electronics etc. Therefore, PTFE industry has been growing significantly.

At present, the PTFE industry still has great development space. In recent years, China has issued a series of industrial policies to support the development of new material industry. For example, the *Three-year Plan on New Material Industry Standardization*, which was published in July 2013, stated that China shall produce PTFE with high-performance and other high-end fluor polymers as well as develop fluorine-containing intermediates and fine chemicals. This has laid a solid policy foundation for the development of PTFE industry.

R22 is the raw material of tetrafluoroethylene (TFE) monomer which is produced by steam dilution cracking method, and TFE is the raw material of PTFE. Suspension PTFE is produced through the polymerization process with the initiator (ammonium persulfate), while dispersion PTFE is produced through the polymerization process with the dispersing agent (ammonium perfluorocaprylate solution).

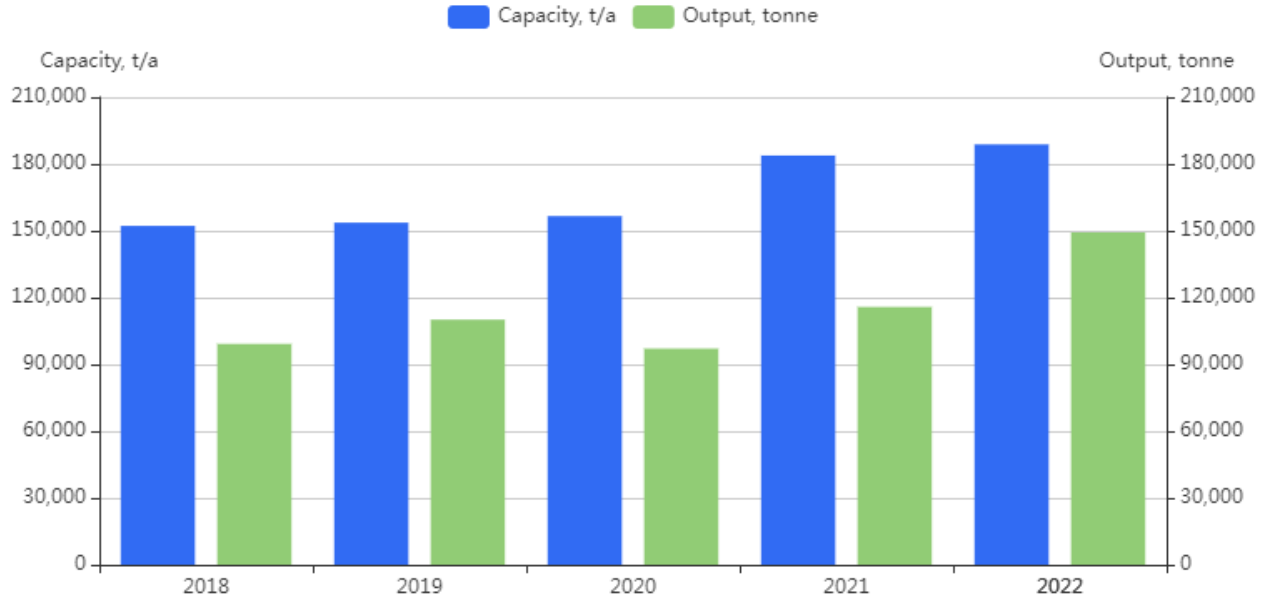
4.2.1.1 Production situation

China has become one of the most important manufacturers of PTFE in the world. The capacity of PTFE in China increased from 151,000 t/a in 2017 to 183,800 t/a in 2021, at a CAGR of 5.0%. During 2017–2020, the industry slowed down its expansion. However, the industry ushered in a new round of capacity expansion as

several planned new projects brought into operation in 2021.

The output of PTFE in China was 110,100 tonnes in 2019. However, the output decreased in 2020 as demand turned sluggish, impacted by the COVID-19. In 2021, the output increased by 19.3% year on year to 115,800 tonnes. In 2022, thanks to the growing demand in 5G and new energy sectors, output of high-end PTFE rose while medium and low-end PTFE showed a downward trend as they entered the stage of overcapacity. Overall, the output of PTFE grew.

Figure 4.2.1.1-1 Capacity and output of PTFE in China, 2018–2022



Source: CCM

In 2022, there were 13 PTFE manufacturers in China and most of them are located in East China. About 50% of the PTFE capacity is concentrated in Shandong Province and Jiangsu Province.

In 2022, domestic capacity and output of PTFE were mainly concentrated in the top five enterprises; their combined capacity and output accounted for about 71.9% and 75.7% of the total in China. Among them, Dongyue Group Ltd. has a complete fluorine industrial chain. Its hydrogen fluoride and chloroform are used as raw materials for its own production of R22, and part of its R22 is used as the raw material for PTFE.

Table 4.2.1.1-1 Main active manufacturers of PTFE in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Dongyue Group Ltd.	Shandong	55,300	55,300	45,000	30,500
2	Zhonghao Chenguang Research Institute of Chemical Industry Co., Ltd.	Sichuan	30,000	30,000	27,450	30,400
3	Zhejiang Juhua Co., Ltd.	Zhejiang	25,000	23,000	20,500	10,000
4	Jiangxi Lee & Man Chemical Co., Ltd.	Jiangxi	16,700	16,700	14,000	12,000
5	Daikin Fluorochemicals (China) Co., Ltd.	Jiangsu	15,300	15,300	10,000	9,500
6	Fujian Sannong New Materials Co., Ltd.	Fujian	12,500	12,500	7,000	5,000
7	Changshu 3F Fuyuan New Materials Co., Ltd.	Jiangsu	11,800	11,800	9,400	8,000

8	Meilan Chemical Group Co., Ltd.	Jiangsu	10,000	7,000	8,000	4,000
9	Jiangxi Zhongfu Chemical Material Technology Co., Ltd.	Jiangxi	5,000	5,000	2,850	1,000
10	Shandong Hua Fluorochemical Co., Ltd.	Shandong	3,600	3,600	2,160	2,500
11	Solvay Specialty Polymers (Changshu) Co., Ltd.	Jiangsu	2,000	2,000	1,500	1,500
12	Luxi Chemical Group Co., Ltd.	Shandong	1,000	1,000	800	800
13	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	600	600	610	600
Total			**188,800**	**183,800**	**149,270**	**115,800**

Source: CCM

Table 4.2.1.1-2 Capacity and share of PTFE manufacturers in China, 2021–2022

Item	Capacity, t/a		Share	
	2022	2021	2022	2021
Top two	85,300	85,300	45.2%	46.4%
Top five	142,300	140,300	75.4%	76.3%

Source: CCM

Table 4.2.1.1-3 Output and share of PTFE manufacturers in China, 2021–2022

Item	Output, tonne		Share	
	2022	2021	2022	2021
Top two	72,450	60,900	48.5%	52.6%
Top five	116,950	92,400	78.3%	79.8%

Source: CCM

4.2.1.2 Price

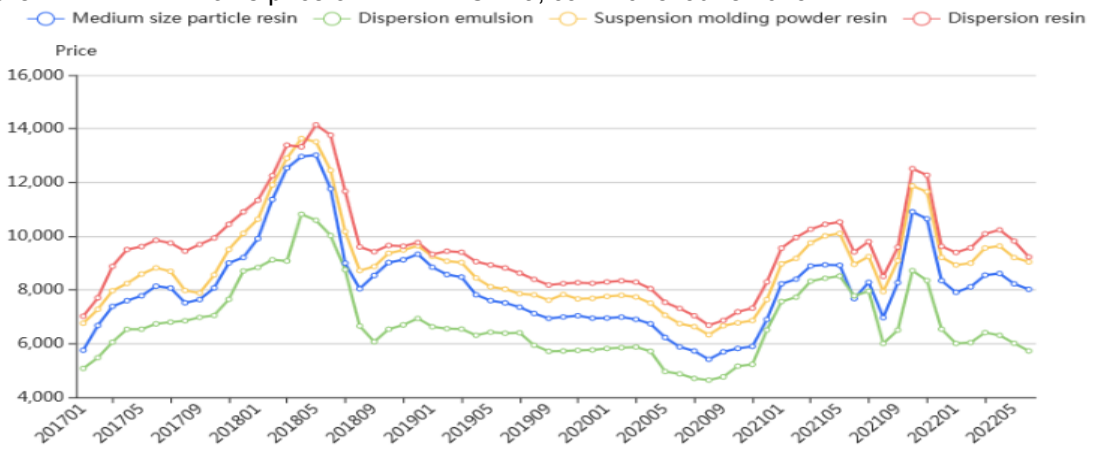
Affected by the increasing price of fluorite and AHF, the price of PTFE increased in Jan. 2017–May 2018.

Since June 2018, due to the US Department of Commerce's preliminary anti-dumping measures on PTFE produced in China and India, and the impact of the Sino-US trade dispute, the price of PTFE fell. The trend did not stop in 2019, as PTFE market competition was increasingly fierce.

In 2020–H1 2022, there was little variation in the demand for PTFE, price changes were mainly inspired by fluctuations in the price of its raw material R22.

Since Sept. 2022, the PTFE price started to decline again as R22 prices have fallen. The overall downward tendency continued until H1 2023.

Figure 4.2.1.2-1 Ex-works price of PTFE in China, Jan. 2018–June 2023



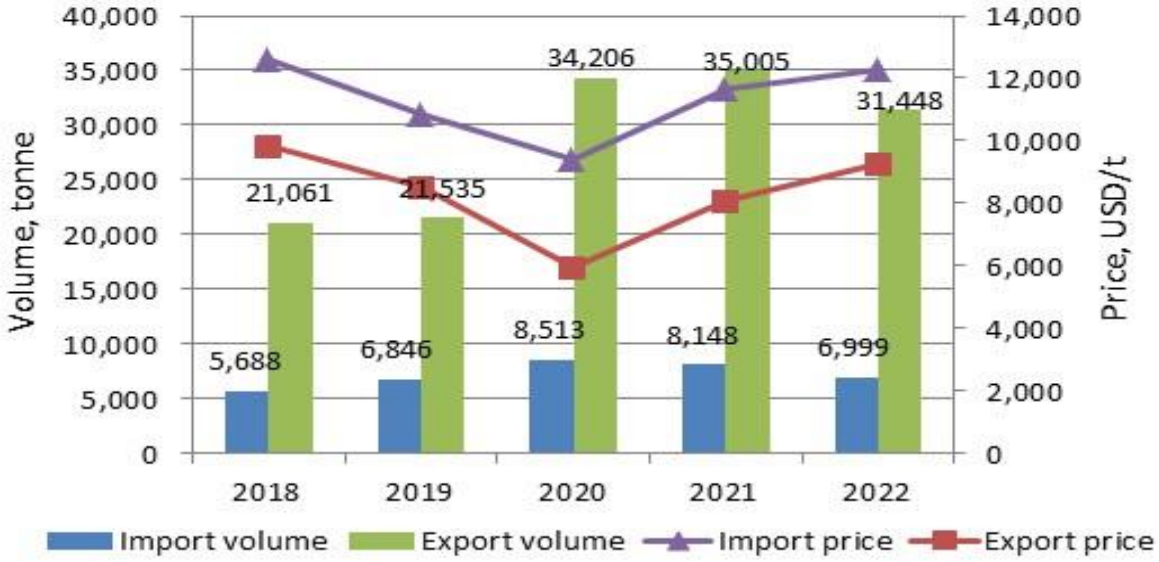
Source: CCM

4.2.1.3 Export and import

In China, the production technology of PTFE industry has gradually become mature, especially in medium- and low-end product fields, so there is no wonder that structural differences in import and export between PTFE products of different grades: medium- and low-end products become export-oriented, while high-end products still rely on imports.

In 2022, China's export volume was still higher than that of import volume. In 2018–2022, the import and export volume of PTFE in China fluctuated. Generally, the average import and export volume of PTFE in China were around 7,000 tonnes and 28,000 tonnes respectively. In 2022, both import and export volumes slid down slightly as the COVID-19 pandemic resurged.

Figure 4.2.1.3-1 China's imports and exports of PTFE, 2018–2022



Source:China Customs & CCM

Table 4.2.1.3-1 China's imports and exports of PTFE, 2018–2022

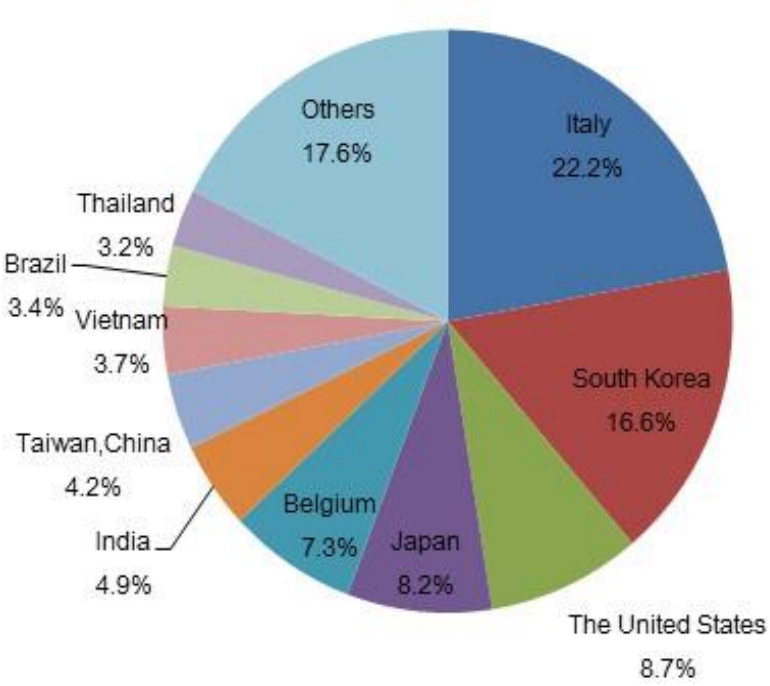
Year	Import			Export		
	Volume, tonne	Value, USD	Price, USD/t	Volume, tonne	Value, USD	Price, USD/t
2018	5,688	71,749,080	12,613	21,061	206,778,695	9,818
2019	6,846	74,301,337	10,854	21,535	184,175,136	8,552

2020	8,513	79,935,742	9,390	34,206	204,093,091	5,967
2021	8,148	95,136,281	11,676	35,005	282,578,994	8,072
2022	6,999	85,742,306	12,251	31,448	292,719,428	9,308

Source:China Customs & CCM

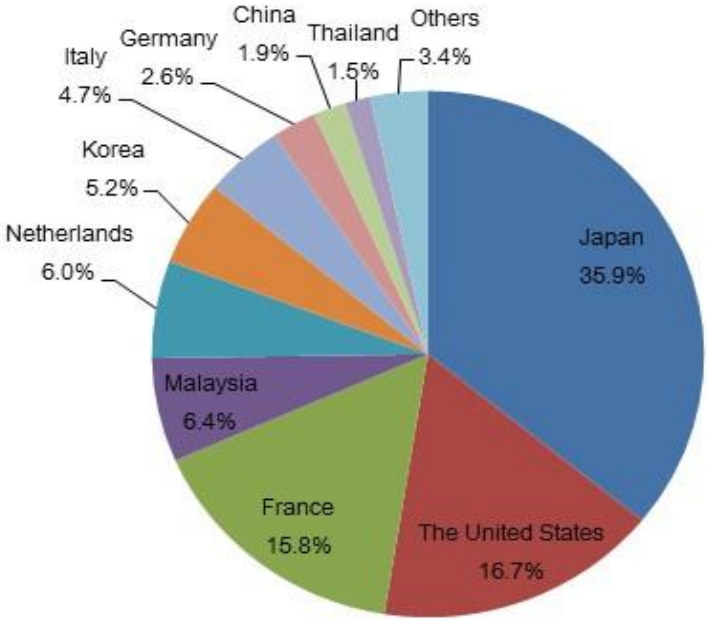
In 2022, export volume of China's PTFE to each of the top 10 export destinations exceeded 1,000 tonnes. Italy topped other countries as the largest export destination, followed by Korea and The United States. As for imports, Japan, Malaysia and Korea were the top three import origins, taking up 51.8% of the total.

Figure 4.2.1.3-2 Top ten export destinations of PTFE from China by volume, 2022



Source:China Customs & CCM

Figure 4.2.1.3-3 Top ten import origins of PTFE in China by volume, 2022



Source:China Customs & CCM

4.2.1.4 Future trends

At present, the capacity of medium- and low-end PTFE in China has been in surplus, while that of high-end PTFE still needs to develop. In the future, PTFE manufacturers will focus more on high-end products.

In the near future, there are some expansion projects:

- Shandong Dongyue Polymer Material Co., Ltd.'s 20,000 t/a project;
- Fujian Haidefu New Material Co., Ltd.'s 2,800 t/a project;
- Zhejiang Yonghe Refrigerant Co., Ltd.'s 18,000 t/a project;

With increasing application of PTFE in 5G communication, environmental protection, automobile, aircraft, medical equipment and other new fields, it will not only prompt the growth of PTFE consumption, but also put forward higher and finer requirements for PTFE performance.

4.2.2 PVDF

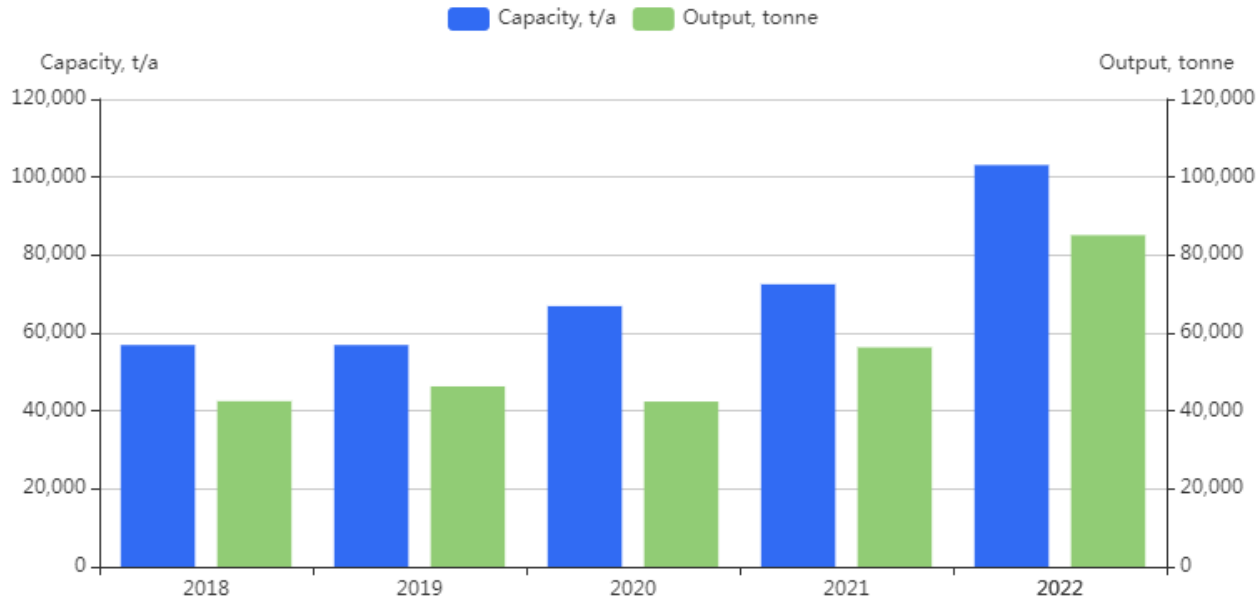
PVDF resin mainly refers to vinylidene fluoride homopolymer or copolymer of vinylidene fluoride and small amounts of other fluorine-containing vinyl monomers. PVDF resin has the characteristics of fluorine resin and normal resin. Besides its good chemical resistance, high temperature resistance, oxidation resistance, weatherability, and radiation-resistant performance, PVDF resin possesses special piezoelectric, dielectric, and thermoelectric properties, etc. It is currently the second largest product by output among fluorine-containing plastics, mainly used in three major areas, namely petrochemical, electronic and electrical, and fluorocarbon coating. In recent years, with Li-ion battery market expanding, PVDF has been served as the adhesives for positive and negative electrode and coatings for lithium battery separators thanks to its the characteristics mentioned above.

4.2.2.1 Production situation

The PVDF industry has developed very quickly in China, influenced by the increasing demand from downstream industries like lithium battery industry, coating industry and solar energy industry. The capacity of PVDF increased from 51,900 t/a in 2017 to 72,500 t/a in 2021, with a CAGR of 8.7%. On the whole, the output showed an upward trend in 2017–2021, except for a dip in 2020.

Affected by the COVID-19 pandemic, the operating rate of PTFE industry decreased significantly in 2020, causing an 8.4% year-on-year fall in the output. Benefiting from the rapid growth of the new energy industry, PVDF saw a surge in demand, and the output in 2021 jumped by 32.8% year on year to 56,300 tonnes. In 2022, NEV market saw rapid growth in both sales and output, pushing the demand for raw materials of power batteries higher than ever. Therefore, the capacity and output of PVDF surged in 2022.

Figure 4.2.2.1-1 Capacity and output of PVDF in China, 2018–2022



Note:The data of 2018–2019 have been revised.
Source: CCM

In 2021, there were 11 active PVDF manufacturers in China and most of them are located in East China. About 55% of the PVDF capacity is concentrated in Jiangsu and Zhejiang provinces.

In China, about half of the capacity and output are concentrated in the top three players, as they have the advantage in R&D, technology and capital. In 2022, most producers maintained a operating rate of more than 90% to ease the tight supply.

Arkema (Changshu) Fluorochemical Co., Ltd. mainly purchases the raw material R152a from Changshu 3F Fluorochemical Industry Co., Ltd., and its products are widely used in the high-end market owing to the high quality and good reputation. Since 2006, the company has invested a lot in the research of PVDF in order to meet the increasing demand from downstream industries such as lithium battery, filtration membrane and solar panel.

Table 4.2.2.1-1 Main active manufacturers of PVDF in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Arkema (Changshu) Fluorochemical Co., Ltd.	Jiangsu	19,000	19,000	17,000	12,400
2	Shandong Huaxia Shenzhou New Material Co., Ltd.	Shandong	10,000	10,000	9,000	8,400
3	Inner Mongolia 3F Wanhao Fluorochemical Co., Ltd.	Inner Mongolia	7,000	7,000	7,000	7,000
4	Zhejiang Fluorine Chemical New Material Co., Ltd.	Zhejiang	6,000	6,000	5,100	4,800
5	Shandong Deyi New Material Co., Ltd.	Shandong	5,000	5,000	5,000	4,700
6	Kureha (Changshu) Fluoropolymers Co., Ltd.	Jiangsu	5,000	5,000	4,750	4,700
7	Ruyuan Dongyangguang Fluorine Resin Co., Ltd.	Guangdong	5,000	5,000	6,200	4,500
8	Solvay Specialty Polymers (Changshu) Co., Ltd.	Jiangsu	4,000	4,000	3,800	3,600
9	Zhejiang Juhua Co., Ltd.	Zhejiang	3,500	3,500	2,975	3,000
10	Sinochem Lantian Fluoro Materials Co., Ltd.	Zhejiang	3,000	3,000	2,900	2,400
11	Shandong Hua'an New Material Co., Ltd.	Shandong	3,000	3,000	2,700	800
Others			32,600	2,000	18,675	0
Total			**103,100**	**72,500**	**85,100**	**56,300**

Note:Longxing Chemical Stock Co., Ltd.' 2,000 t/a production line suspended since 2019.
Source: CCM

Table 4.2.2.1-2 Production share of top three PVDF manufacturers in China, 2020–2021

Item	2022	2021	Share	
			2022	2021
Capacity, t/a	36,000	36,000	34.9%	49.7%
Output, tonne	33,000	27,800	38.8%	49.4%

Source: CCM

4.2.2.2 Price

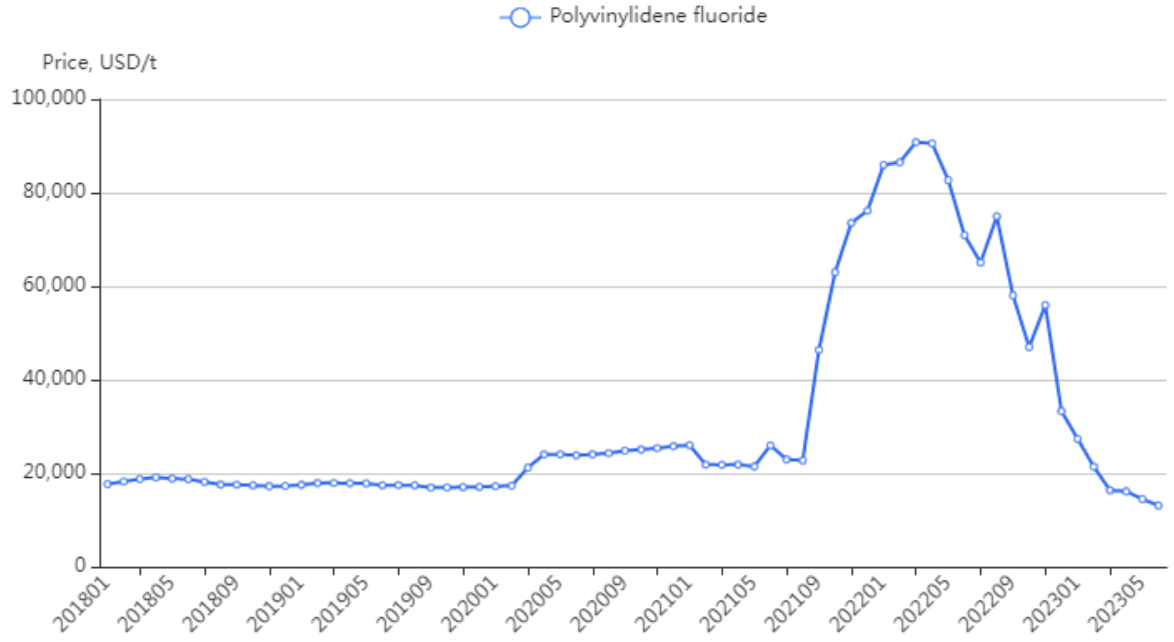
On the whole, from Jan. 2017 to June 2022, the price trend of PVDF in China came in two stages:

- Jan. 2017–Aug. 2021: during this period, PVDF market was in a situation where supply exceeded demand, and PVDF price maintained relatively stable, mainly supported by production cost.
- Sept. 2021–June 2022: strong demand for PVDF from downstream industries pushed the price of PVDF up significantly. Although the price declined in Q2 2022, it was still at a very high level compared with the first stage.

Since H2 2020, PVDF has seen improved downstream demand in China, but the overall growth was not significant, affected by the COVID-19 pandemic. From H2 2021, PVDF was in short supply in domestic market. Therefore, its price soared. At the same time, increasing raw material prices also contributed to the price surge. Under the explosive demand growth for the raw material R142b, the price of R142b rose, which in turn supported the price of PVDF.

In H2 2022, PVDF prices were volatile and trended downwards. During this period, numerous new production lines begin operation, driving an unprecedented increase in PVDF capacity, while R142b prices decline during this period. As the industry moved into overcapacity and production costs decreased, PVDF prices eventually fell back to normal levels. And it is likely that prices will not spike in the coming years, at least not as much as they did in 2021–H1 2022.

Figure 4.2.2.2-1 Ex-works price of PVDF in China, Jan. 2018–June 2023



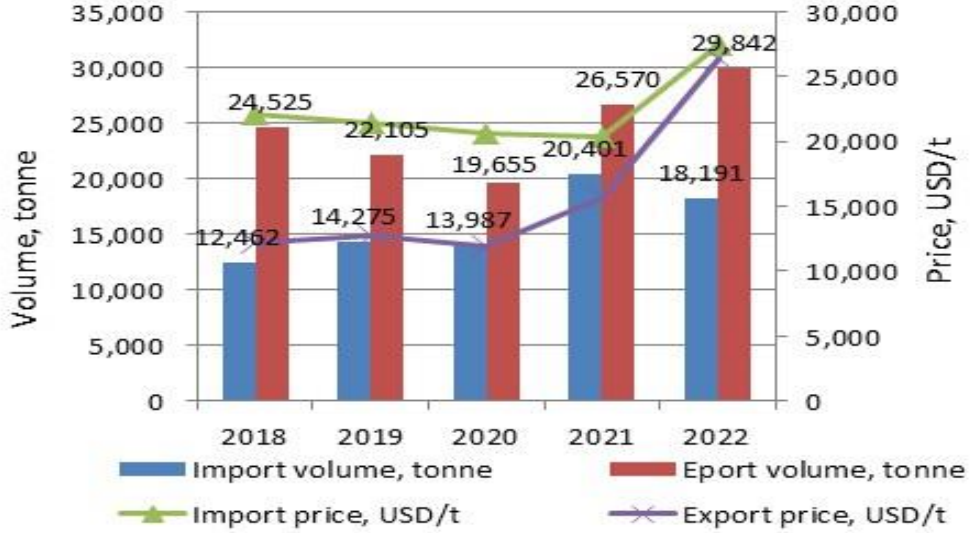
Source: CCM

4.2.2.3 Export and import

In 2017–2020, the import volume of other kinds of fluoride polymers in China fluctuated in a small range, but it jumped by 45.9% year on year to 20,401 tonnes in 2021, driven by booming downstream demand, especially from the lithium-ion battery industry.

The export volume increased slightly in 2018, but it dropped to 22,105 tonnes in 2019, and fell further to 19,655 tonnes in 2020, impacted by the COVID-19 epidemic. In 2021, with the eased pandemic, demand for lithium-ion batteries saw explosive growth along with the popularity of new energy vehicles around the world, thus driving up export of other kinds of fluoride polymers. PVDF export, in particular, contributed a lot to the increase. In 2022, China's increasing capacity of fluoride polymers gave rise to the export volume at 29,842 tonnes; in contrast, the import volume in the year dropped to 18,191 tonnes.

Figure 4.2.2.3-1 Imports and exports of other kinds of fluoride polymers in China, 2018–2022



Note:The fluoride polymers here mainly include PVDF, ETFE, TFE, etc.
Source:China Customs & CCM

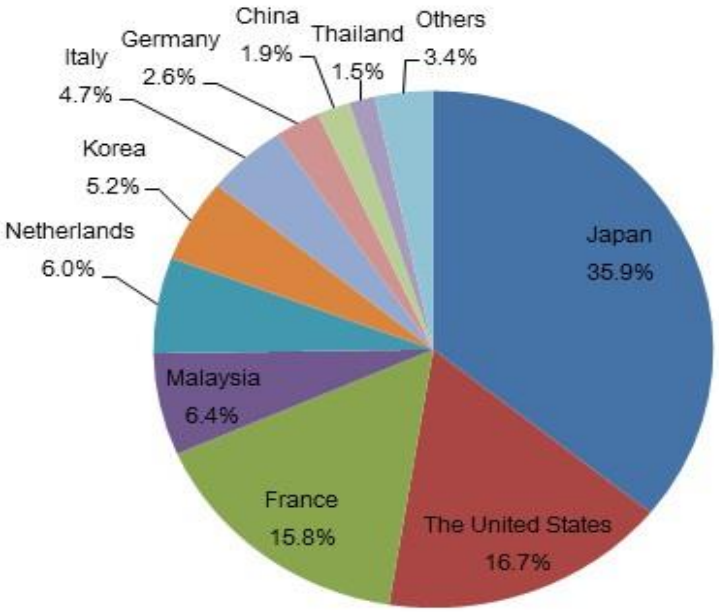
Table 4.2.2.3-1 Imports and exports of other kinds of fluoride polymers in China, 2018–2022

Year	Import			Export		
	Volume, tonne	Value, USD	Price, USD/t	Volume, tonne	Value, USD	Price, USD/t
2018	12,462	275,016,151	22,069	24,525	300,217,645	12,241
2019	14,275	305,023,132	21,368	22,105	281,837,580	12,750
2020	13,987	289,127,534	20,671	19,655	233,376,013	11,874
2021	20,401	416,125,492	20,397	26,570	414,807,085	15,612
2022	18,191	499,639,799	27,466	29,842	788,099,261	26,409

Note:The fluoride polymers here mainly include PVDF, ETFE, TFE, etc.
Source:China Customs & CCM

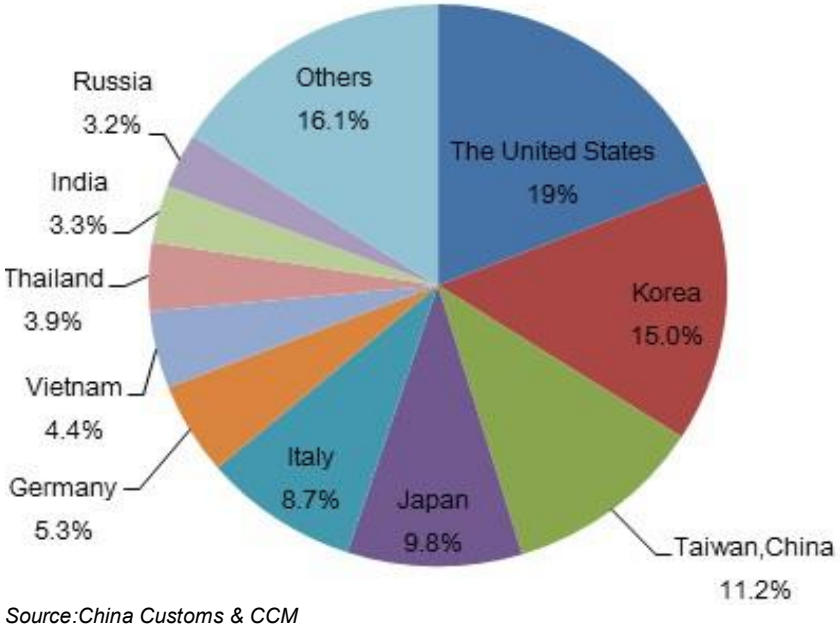
In 2022, Japan was again the largest import origin of other kinds of fluoride polymers to China, accounting for 35.9% of the total import volume, followed by the United States, France and Malaysia. The top three export destinations by volume were the US and Taiwan Province, the three together accounting for 43.3% of the total export volume.

Figure 4.2.2.3-2 Top ten import origins of other kinds of fluoride polymers in China by volume, 2022



Source:China Customs & CCM

Figure 4.2.2.3-3 Top ten export destinations of other kinds of fluoride polymers from China by volume, 2022



Source:China Customs & CCM

4.2.2.4 Future trends

Domestic PVDF product structure is seriously unbalanced, with the products mainly satisfying low-end applications. In terms of application of domestic PVDF products, fluorocarbon coatings and fluororesins are the predominant application fields, and lithium-ion battery binders are entering the mainstream. Among them, the consumption of PVDF resin in the production of coating takes the largest part, and demand from the solar backsheet membrane and lithium-ion battery binder grows fastest.

Apart from being a key material in advanced defence military industry, high-end PVDF also becomes suitable for emerging fields for civilian use. At present, the photovoltaic industry, new energy industry and new materials industry are in rapid growth, and the demand for PVDF surges. However, the output of high-end PVDF products is small in China, and the products are monopolized by international brands. China mainly relies on import to meet the demand. As the lithium-ion battery market is developing rapidly, the demand from adhesive market is expected to increase greatly, and the consumption structure of PVDF will undergo a large adjustment in the next few years.

Currently, most of the domestic PVDF products are not of high quality, and are mainly used in fluorine coatings. Only some products can meet the requirements of lithium-ion battery binders. Therefore, it is expected that domestic PVDF manufacturers will pay more attention to the development, production and application of high-end products in the future.

4.2.3 FEP

Fluorinated ethylene propylene (FEP), commonly known as F46, is the copolymer of TFE and HFP, and the modified material of PTFE.

Based on the needs of processing, there are three kinds of FEP: granular material, dispersion and lacquer material. The granular material can be used for molding, extrusion and injection molding according to its melting index. Dispersion is used for impregnation sintering, and lacquer material is applied in spraying and so on.

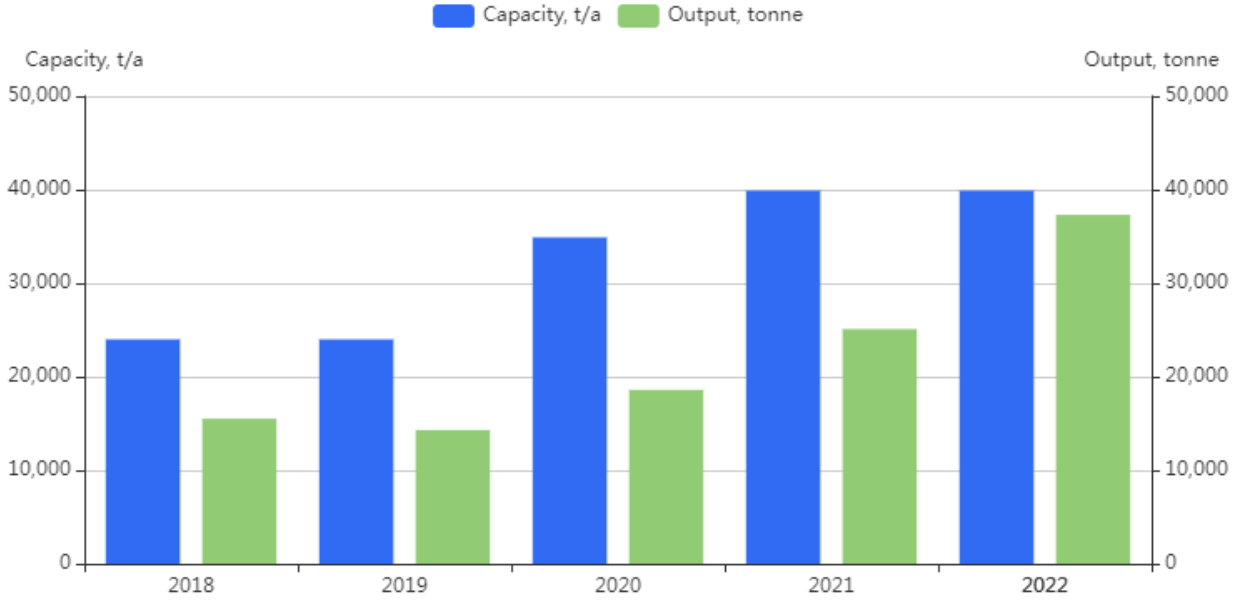
FEP resin has a fairly definite melting point and can be formed and processed by the general thermoplastic process, which greatly simplifies the processing technique. This is the main reason why using HFP to modify PTFE which doesn't have such a feature.

FEP is mainly used in communication cables and wires, semiconductors, chemical anticorrosion, medical materials, automobiles and industrial coatings.

Because of the increasing demand from the electrical wire and cable industry, the capacity and output of FEP in China witnessed an increase in 2018–2021, to 39,900 t/a and 25,100 tonnes in 2021 respectively.

In 2022, new production lines began to be constructed in China as a result of the increase in high-voltage power transmission projects and demand for FEP, which is one of the raw materials for wires and cables.

Figure 4.2.3-1 Capacity and output of FEP in China, 2018–2022



Source: CCM

In 2021, there were 9 FEP producers in China, with Shandong Huaxia Shenzhou New Material Co., Ltd. (Huaxia Shenzhou) ranking the first. The capacity of FEP in Huaxia Shenzhou increased from 5,600 t/a in 2020 to 10,600 t/a in 2021, accounting for 26.6% of the total capacity in China, which helped reinforce the company's leadership in China's FEP industry.

Table 4.2.3-1 Active manufacturers of FEP in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Shandong Huaxia Shenzhou New Material Co., Ltd.	Shandong	10,600	10,600	9,000	4,500
2	Daikin Fluorochemicals (China) Co., Ltd.	Jiangsu	6,000	6,000	5,100	4,000
3	Zhejiang Juhua Co., Ltd.	Zhejiang	5,000	5,000	8,200	3,300
4	Liaocheng Fuer New Material Technology Co., Ltd.	Shandong	5,000	5,000	4,050	3,100
5	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	4,200	4,200	4,400	4,600
6	Changshu 3F Fuyuan New Materials Co., Ltd.	Jiangsu	3,500	3,500	2,400	2,160
7	Taixing Meilan New Materials Co., Ltd.	Jiangsu	3,000	3,000	2,100	2,000
8	Chongqing Xinfu Technology Co., Ltd.	Chongqing	2,500	2,500	2,000	1,400
9	Shandong Hua Fluorochemical Co., Ltd.	Shandong	100	100	60	40
Total			**39,900**	**39,900**	**37,310**	**25,100**

Source: CCM

4.2.4 Fluor rubber

Fluor rubber, known as FKM, is one of synthesized elastomer whose carbon has fluorine atom in main chain or side chain. With characteristics of heat resistance, oil resistance, solvent resistance and good mechanical properties, fluor rubber is widely applied in national defense, military, aerospace, automobile, and petrochemical industries. Fluor rubber has become an indispensable fundamental material in modern industry.

China developed fluor rubber in 1958 mainly because of the demand from the military industry and then it began to be applied in civilian industry gradually. With the rapid development of Chinese automobile industry in recent years, the demand for fluor rubber increased rapidly. There are four main fluor rubbers produced in China:

- Fluor rubber 26, copolymer of VDF and HFP
- Fluor rubber 246, copolymer of VDF, TFE and HFP
- Fluor rubber TP, copolymer of TFE and propylene
- Fluorinated silicon rubber

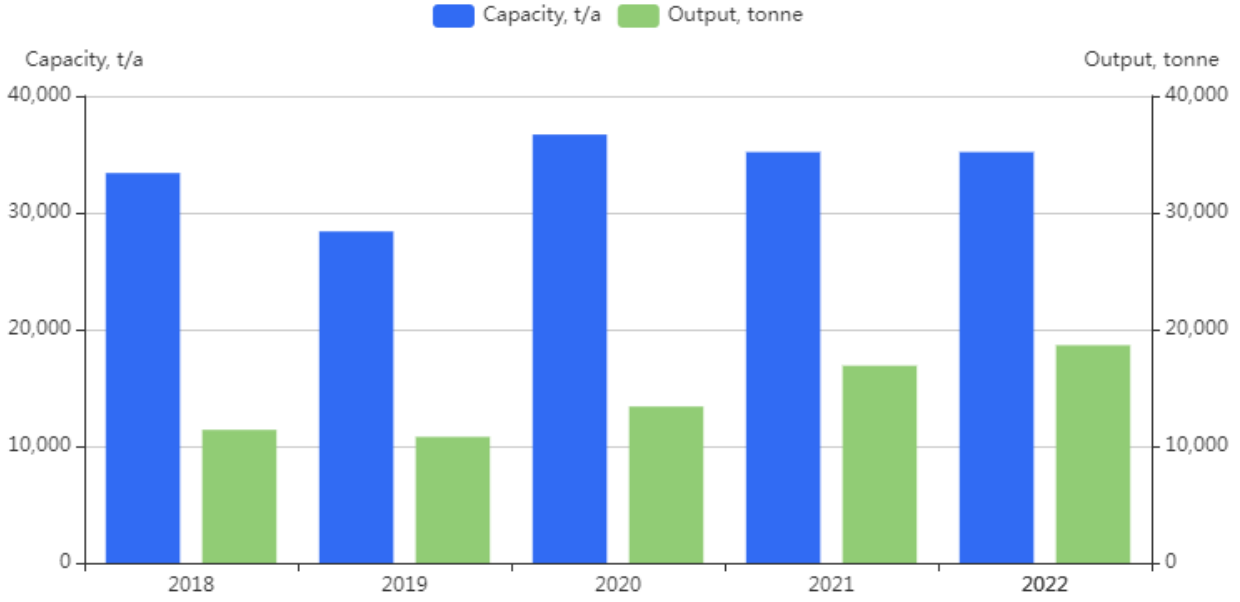
There are also some products with small output such as fluor rubber 23 (copolymer of VDF and CTFE) and perfluoroelastomers which are applied in military industry.

Subject to the backwardness of processing and application technology, the production of fluor rubber products is mainly concentrated in foreign giants. Compared with foreign countries, China still lags behind in the variety and application of fluor rubber products. In addition, fluor rubber localization rate is not high in China, and high-end fluor rubber products still rely on import to meet market demand.

In 2018–2021, the capacity of fluor rubber in China fluctuated; it was 35,200 t/a in 2021. The output rebounded in 2020 after declines in 2018 and 2019. During 2020–2021, increasing demand from downstream markets, especially in the automotive industry, led to a surge in the output of fluor rubber.

In 2022, the development pace of fluor rubber industry of China remained at a low level. On the one hand, the growing market of NEVs in China have been slowly taking up the share of traditonal internal combustion engine vehicles market which is the vital downstream demand source of FKM, leading to the overcapacity of low and medium-end FKM; on the other hand, high-end FKM demand as well as import are still on the rise while few high-end FKM Chinese producers were seen.

Figure 4.2.4-1 Capacity and output of fluor rubber in China, 2018–2022



Source: CCM

In 2022, there were 10 fluor rubber producers in China. The largest manufacturer in China was Shandong Huaxia Shenzhou New Material Co., Ltd., with 10,000 t/a production capacity, or 28.4% of the national total.

Table 4.2.4-1 Active manufacturers of fluor rubber in China, 2021–2022

No.	Producer		Location	Capacity, t/a		Output, tonne	
				2022	2021	2022	2021
1	Shandong Huaxia Shenzhou New Material Co., Ltd.		Shandong	10,000	10,000	2,500	2,600
2	Daikin Fluorochemicals (China) Co., Ltd.		Jiangsu	6,000	6,000	3,800	3,800
3	Haohua Technology	The Chemours Chenguang Fluoromaterials (Shanghai) Co., Ltd.	Shanghai	4,000	4,000	3,100	3,000
		Zhonghao Chenguang Research Institute of Chemical Industry Co., Ltd.	Sichuan	1,500	1,500	1,900	1,800
4	3F	Inner Mongolia 3F Wanhao Fluorochemical Co., Ltd.	Inner Mongolia	3,500	3,500	800	1,000
		Changshu 3F Fuyuan New Materials Co., Ltd.	Jiangsu	1,000	1,000	700	600
5	Solvay Specialty Polymers (Changshu) Co., Ltd.		Jiangsu	3,000	3,000	1,650	1,500
6	Zhejiang Juhua Co., Ltd.		Zhejiang	3,000	3,000	2,400	1,100
7	Jiangsu Meilan Chemical Co., Ltd.		Jiangsu	2,000	2,000	1,000	800
8	Zhejiang Fluorine Chemical New Material Co., Ltd.		Zhejiang	1,200	1,200	800	700
Total				**35,200**	**35,200**	**18,650**	**16,900**

Source: CCM

4.2.5 Monomer

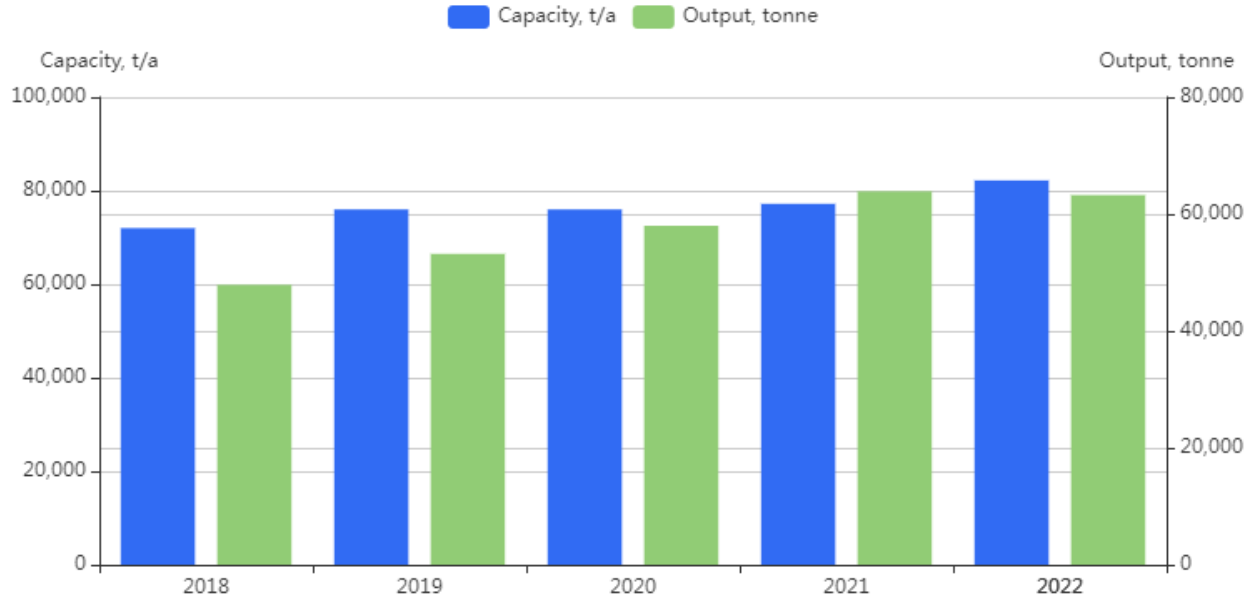
4.2.5.1 HFP

Hexafluoropropylene (HFP) is an important perfluoro intermediate used in the organic fluorine industry. It is one of the monomers of fluorinated polymer materials. HFP is widely used to make a variety of fluoridated fine chemical products, pharmaceutical intermediates, fire extinguishing agents, etc.

- Production

The growth of capacity of HFP slowed down in China, slowly increasing from 72,000 t/a in 2018 to 82,200 t/a in 2022. Meanwhile, boosted by the development of downstream industries, HFP output increased quickly to 63,250 tonnes in 2022 from 47,900 tonnes in 2018, with a CAGR of 7.2% in this period. In 2022, output of HFP dropped slightly. Downstream demand remained almost the same as in 2021 while new production lines were under construction.

Figure 4.2.5.1-1 Capacity and output of HFP in China, 2018–2022



Source: CCM

The production of HFP is mainly concentrated in East China. Zhejiang Juhua Co., Ltd., Changshu 3F Zhonghao New Chemical Materials Co., Ltd. and Shandong Dongyue Polymer Material Co., Ltd. are the three largest HFP manufacturers in China, and their capacity together accounted for 50.5% of the total in 2021.

Table 4.2.5.1-1 Main active manufacturers of HFP in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Zhejiang Juhua Co., Ltd.	Zhejiang	20,000	15,000	13,600	12,900
2	Changshu 3F Zhonghao New Chemical Materials Co., Ltd.	Jiangsu	14,000	14,000	11,000	10,000
3	Shandong Dongyue Polymer Material Co., Ltd.	Shandong	10,000	10,000	7,000	8,200
4	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	8,000	8,000	8,100	10,000
5	Changshu 3F Fluorochemical Industry Co., Ltd.	Jiangsu	6,000	6,000	4,800	4,500

6	Taixing Meilan New Materials Co., Ltd.	Jiangsu	5,400	5,400	3,800	3,500
7	Fujian Sannong New Materials Co., Ltd.	Fujian	5,000	5,000	4,050	4,000
8	Jiangxi Lee & Man Chemical Co., Ltd.	Jiangxi	3,200	3,200	2,500	2,000
9	Zhonghao Chenguang Research Institute of Chemical Industry Co., Ltd.	Sichuan	3,000	3,000	2,400	2,700
10	Daikin Fluorochemicals (China) Co., Ltd.	Jiangsu	3,000	3,000	2,200	2,300
11	Liaocheng Fuer New Material Technology Co., Ltd.	Shandong	2,000	2,000	1,600	1,600
Others			2,600	2,600	2,200	2,200
Total			**82,200**	**77,200**	**63,250**	**63,900**

Source: CCM

- Price

In 2017–H1 2020, the ex-works price of HFP in China witnessed ups and downs. Price fluctuated between USD6,655/t and USD8,720/t in Q1–Q3 2017, and peaked at USD10,668/t in April 2018. After that, the price almost kept falling for quite a while, closing at USD4,101/t in Aug. 2020, although there was a short increase in Q4 2018. Two things contributed to this drop. First, the demand for HFP was weak. Second, falling price of AHF brought down the production cost of HFP, so the price lost some support.

From Sept. 2020–June 2022, HFP price was highly volatile, as prices of its raw materials AHF and chloroform fluctuated during this period.

Figure 4.2.5.1-2 Ex-works price of HFP in China, Jan. 2018–June 2023

Source: CCM

4.2.5.2 CTFE

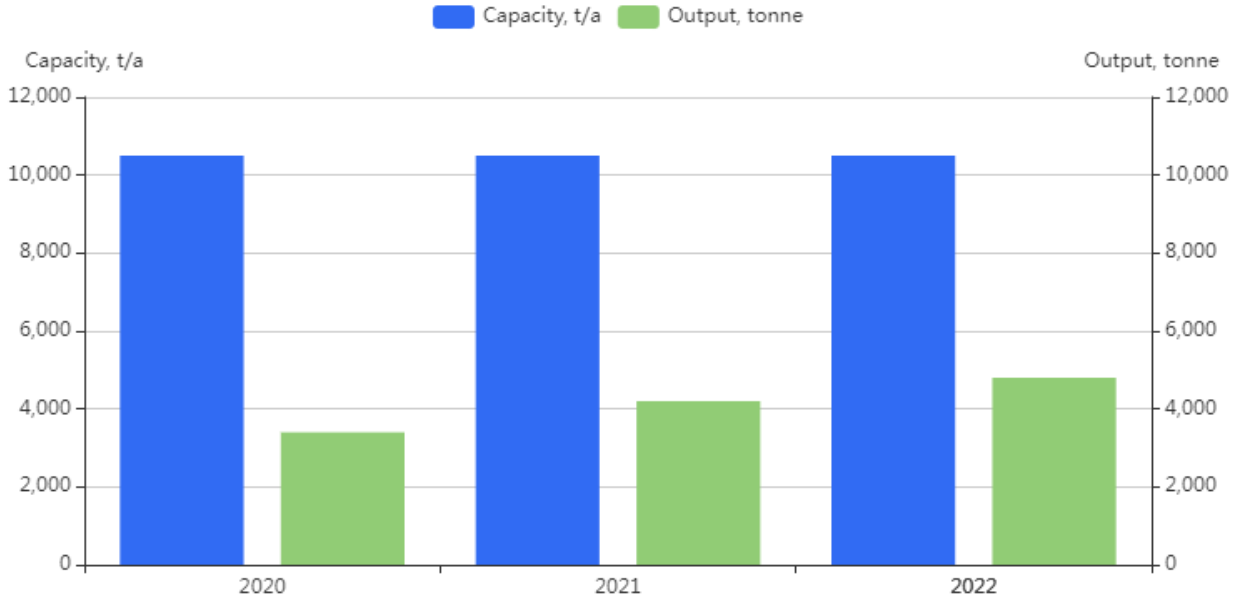
Chlorotrifluoroethylene (CTFE) has uses in a wide variety of industries. CTFE is non-flammable and chemical resistant; it possesses near-zero moisture absorption, and boasts superior electric property over other thermoplastic fluor polymers such as PTFE. Common applications of CTFE include:

- Electronics: CTFE is used as moisture barriers for sensitive electronic components, such as LCD panels in televisions and computer monitors.
- Medical/Research/Pharmaceutical: With low outgassing rate and permeability, CTFE can be used in

specialized applications, such as laboratory instrumentation and tools. In pharmaceutical industry, the material is used as moisture barriers in packaging.
● Semiconductors: Some semiconductor process components are often made from CTFE, such as wafer boats. The high strength and favorable electric property of this material make it ideal for these applications.
● High-vacuum: Due to exceptional stability, crack resistance, and corrosion resistance, CTFE is used in high-vacuum applications.

In China, production capacity and output of CTFE are small compared with other fluoride polymer monomers. In 2020–2022, there were only four CTFE manufacturers, with 10,500 t/a capacity in total. Meanwhile, the output of CTFE showed gradual growth in the past three years. In 2022, markets of semiconductors, electronics continued to grow, but the output of CTFE still hovered below 5,000 tonnes.

Figure 4.2.5.2-1 Capacity and output of CTFE in China, 2020–2022



Source: CCM

Table 4.2.5.2-1 Manufacturers of CTFE in China, 2021–2022

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2022	2021	2022	2021
1	Changshu 3F Fluorochemical Industry Co., Ltd.	Jiangsu	3,000	3,000	1,500	1,200
2	Changshu 3F Zhonghao New Chemical Materials Co., Ltd.	Jiangsu	2,000	2,000	800	800
3	Chenzhou Sinochem Fuyuan New Materials Co., Ltd.	Hunan	3,000	3,000	1,300	1,200
4	Jiangsu Bluestar Green Technology Co., Ltd.	Jiangsu	2,500	2,500	1,200	1,000
Total			**10,500**	**10,500**	**4,800**	**4,200**

Source: CCM

4.2.5.3 VDF

Vinylidene fluoride (VDF) is mainly used to produce polyvinylidene fluoride (PVDF) and fluor rubbers. In China, most PVDF and fluoro rubber manufacturers are equipped with VDF production plant to produce it for self-use; usually little is for sale.

As the reactive monomer of PVDF and fluor rubbers, VDF capacity expansion is decided by the demand for

VDF. Overall, downstream sectors have strong demand for PVDF and fluor rubbers, especially for PVDF. Thus, the demand for VDF will continue to increase. Good development prospects will attract potential entrants into the industry in the future.

In 2021, thanks to surging downstream demand, operating rates of most VDF enterprises were at a high level. In 2022, demand for PVDF continued to rise, pushing the output of VDF higher. In addition, new production lines are being built and planned. In 2022, there were 14 VDF manufacturers in China with the total capacity and output reaching 131,800 t/a and 86,340 tonnes respectively.

Table 4.2.5.3-1 Manufacturers of VDF in China, 2022

No.	Producer	Location	Capacity, t/a	Output, tonne
1	Shandong Huaxia Shenzhou New Material Co., Ltd.	Shandong Province	23,000	20,700
2	Shandong Deyi New Material Co., Ltd.	Shandong Province	21,000	4,000
3	Arkema (Changshu) Fluorochemical Co., Ltd.	Jiangsu Prvince	12,000	9,600
4	Inner Mongolia 3F Wanhao Fluorochemical Co., Ltd.	Inner Mongolia Autonomous Region	13,000	8,840
5	Zhejiang Juhua Co., Ltd.	Zhejiang Province	12,000	6,600
6	Solvay Specialty Polymers (Changshu) Co., Ltd.	Jiangsu Prvince	10,000	7,000
7	Shandong Hua'an New Material Co., Ltd.	Shandong Province	8,600	1,700
8	Zhejiang Fluorine Chemical New Material Co., Ltd.	Zhejiang Province	8,000	6,800
9	Changshu 3F Zhenfu New Materials Co., Ltd.	Jiangsu Province	6,000	5,400
10	Daikin Fluorochemicals (China) Co., Ltd.	Jiangsu Province	5,000	4,500
11	Ruyuan Dongyangguang Fluorine Resin Co., Ltd.	Guangdong Province	5,000	4,100
12	Zhonghao Chenguang Research Institute of Chemical Industry Co., Ltd.	Sichuan Province	3,500	3,150
13	Sinochem Lantian Fluoro Materials Co., Ltd.	Zhejiang Province	3,200	2,720
14	Jiangsu Meilan Chemical Co., Ltd.	Jiangsu Province	1,500	1,230
Total			**131,800**	**86,340**

Source: CCM

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