CCM Data & Business Intelligence

Survey of Fluorohydrocarbon in China

The Sixth Edition

October 2022

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Executive summary

Fluorine chemical industry has been one of the fastest developing and most promising chemical industries in China, which has become an important part of national strategic emerging industries. As an important part of fluorine chemical industry, fluorohydrocarbon is used in various industries such as refrigerant, foaming agent, extinguishant, insecticide, medical and chemical. Among them, the refrigerant industry shares the largest consumption of fluorohydrocarbon.

China agreed to take steps to phase out HCFCs. In order to achieve targets set in the phase-out plan of HCFCs, China implements quota management system for production and use of HCFCs Since 2013. In recent years, the total production quota of HCFCs has seen a general decrease and has been concentrating in large enterprises.

At present, the main fluorine refrigerants in China are R22, R134a, R32, R125 and R410a. With the capacity and output of 857,900 t/a and 707,500 tonnes respectively in 2021, R22 is still a major refrigerant in China. Its production quota and consumption volume as a refrigerant has been decreasing, 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.

However, HFCs are not the final alternative to HCFCs because HFCs still have global warming potential (GWP). Therefore, Chinese refrigerant enterprises have been actively looking for safer and more environmentally friendly refrigerants such as CFOs, close-to-natural refrigerants and natural refrigerants.

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 fluorohydrocarbon industry in China.

Interviewees cover:

- Major manufacturers of fluorite
- Major manufacturers of fluorohydrocarbon
- Major consumer enterprises
- 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(s): hydrochlorofluorocarbon(s)
CFC(s): chlorofluorocarbon(s)
HFC(s): hydrofluorocarbon(s)
HC(s): hydrocarbon(s)
ODP: ozone depletion potential
GWP: global warming potential
R22: difluorochloromethane
R134a: 1,1,1,2-tetrafluoroethane
R32: difluoromethane
R125: pentafluoroethane
R410a: mixture of R32 and R125

- 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 null-1 Exchange rate of USD/CNY, Jan. 2017–Aug. 2022

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
2017	6.8918	6.8713	6.8932	6.8845	6.8827	6.8019	6.7772	6.7148	6.5909	6.6493	6.6300	6.6067	6.7662
2018	6.5079	6.3045	6.3352	6.2764	6.3670	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	-	-	-	-	-

Source: The People's Bank of China

1 Development of fluorohydrocarbon

Fluorohydrocarbon is used in various industries such as refrigerant, foaming agent, extinguishant, insecticide, medical and chemical. Among them, the refrigerant industry shares the largest consumption of fuorohydrocarbon.

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.

1.1 Overview of fluorohydrocarbon industry in China

Refrigerants are mainly used in household refrigerators, automobiles, marine and household air conditioners, commercial refrigeration equipment, etc. Not only can they be used in producing new equipment, but also in maintenance. Currently, a replacement wave of refrigerants is being constantly accelerated in China.

China had completely eliminated CFCs in 2007, ahead of the deadline in 2010 prescribed in the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol). Now HCFCs and HFCs are the representative fuorohydrocarbons in the Chinese market. However, due to HCFCs' high ODP, though they are the dominant refrigerants in China, their elimination is on the schedule, which, of course, will greatly affect refrigerant industry in China. In addition, with GWP of HFCs, under the *Kigali Amendment to the Montreal Protocol*, China is mandated to reduce the use of HFCs by 85% of the average value in 2020–2022 by the year 2045.

Table 1.1-1 Refrigerants and phase-out plan in China

Category	Product code	English Name	ODP	GWP	Phase-out plan
CFCs	/	/	N/A	N/A	Under the Montreal Protocol, from 1 Jan., 2010, a total ban, except for special usage, on the production and consumption of CFCs came into effect.
HCFCs	R21	Dichloromonofluoromethane	0.04	N/A	Under the Montreal Protocol, in China, it's agreed to keep the consumption and production of HCFCs 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 based on the level of 2013. Furthermore, HCFCs are expected to be eliminated completely by 2040 except for special usage.
	R22	Difluorochloromethane	0.055	N/A	
	R31	Chlorofluoromethane	0.02	N/A	
	R121	1-Fluoro-1,1,2,2-tetrachloroethane	0.01–0.04	N/A	
	R122	1,1-Difluoro-1,2,2-trichloroethane	0.02–0.08	N/A	
	R123	1,1-Dichloro-2,2,2-trifluoroethane	0.02–0.06	N/A	
	R124	2-Chloro-1,1,1,2-tetrafluoroethane	0.02–0.04	N/A	
	R131	1-Fluoro-1,2,2-trichloroethane	0.007–0.05	N/A	
	R132	1,2-Dichloro-1,2-difluoroethane	0.008–0.05	N/A	
	R133	2-Chloro-1,1,1-trifluoroethane	0.02–0.06	N/A	
	R141	1,2-Dichlorofluoroethane	0.005–0.07	N/A	
	R141b	Dichlorofluoroethane	0.01	N/A	
	R142	1-Chloro-1,1-difluoroethane	0.008–0.07	N/A	
	R142b	Chlorodifluoroethane	0.065	N/A	
	R151	1-Chloro-2-fluoroethane	0.003–0.005	N/A	
	R221	1,1,1,2,2,3-Hexachloro-3-fluoropropane	0.015–0.07	N/A	

	R222	1,1,1,3,3-Pentachloro-2,2-difluoropropane	0.01–0.09	N/A	
	R223	Tetrachlorotrifluoropropane	0.01–0.08	N/A	
	R224	Trichlorotetrafluoropropane	0.01–0.09	N/A	
	R225	1,2-Dichloro-1,1,3,3,3-Pentafluoropropane	0.02–0.07	N/A	
	R225ca	3,3-Dichloro-1,1,1,2,2-pentafluoropropane	0.025	N/A	
	R225cb	1,3-Dichloro-1,1,2,2,3-Pentafluoropropane	0.033	N/A	
	R226	Chlorohexafluoropropane	0.02–0.10	N/A	
	R231	1,1,1,2,3-Pentachloro-2-fluoropropane	0.05–0.09	N/A	
	R232	1,1,1,3-Tetrachloro-3,3-difluoropropane	0.008–0.10	N/A	
	R233	Trichlorotrifluoropropane	0.007–0.23	N/A	
	R234	1,2-Dichloro-1,2,3,3-tetrafluoropropane	0.01–0.28	N/A	
	R235	Chloropentafluoropropane	0.03–0.52	N/A	
	R241	1,1,2,3-Tetrachloro-1-fluoropropane	0.004–0.09	N/A	
	R242	1,3,3-Trichloro-1,1-difluoropropane	0.005–0.13	N/A	
	R243	Dichlorotrifluoropropane	0.007–0.12	N/A	
	R244	Chlorotetrafluoropropane	0.009–0.14	N/A	
	R251	1,1,2-Trichloro-1-fluoropropane	0.001–0.01	N/A	
	R252	Dichlorodifluoropropane	0.005–0.04	N/A	
	R253	Chlorotrifluoropropane	0.003–0.03	N/A	

	R261	Dichlorofluoropropane	0.002–0.02	N/A	
	R262	Chlorodifluoropropane	0.002–0.02	N/A	
	R271	Chlorofluoropropane	0.001–0.03	N/A	
HFCs	R134a	1,1,1,2-Tetrafluoroethane	0	1,300	Under the Kigali Amendment to the Montreal Protocol, China is mandated to reduce the use of HFCs by 80% of the average value in 2020–2022 by the year 2045.
	R125	Pentafluoroethane	0	3,800	
	R407c (R32/R125/R134a)	Difluoromethane (23%)/Pentafluoroethane (25%)/1,1,1,2-Tetrafluoroethane (52%)	0	1,700	
	R410a (R32/R125)	Difluoromethane (50%)/Pentafluoroethane (50%)	0	1,975	
	R143a	1,1,1-Trifluoroethane	0	5,400	
	R32	Difluoromethane	0	675	
	R161	Fluoroethane	0	12	

Source: Ministry of Ecology and Environment of the People's Republic of China (MEE) & CCM

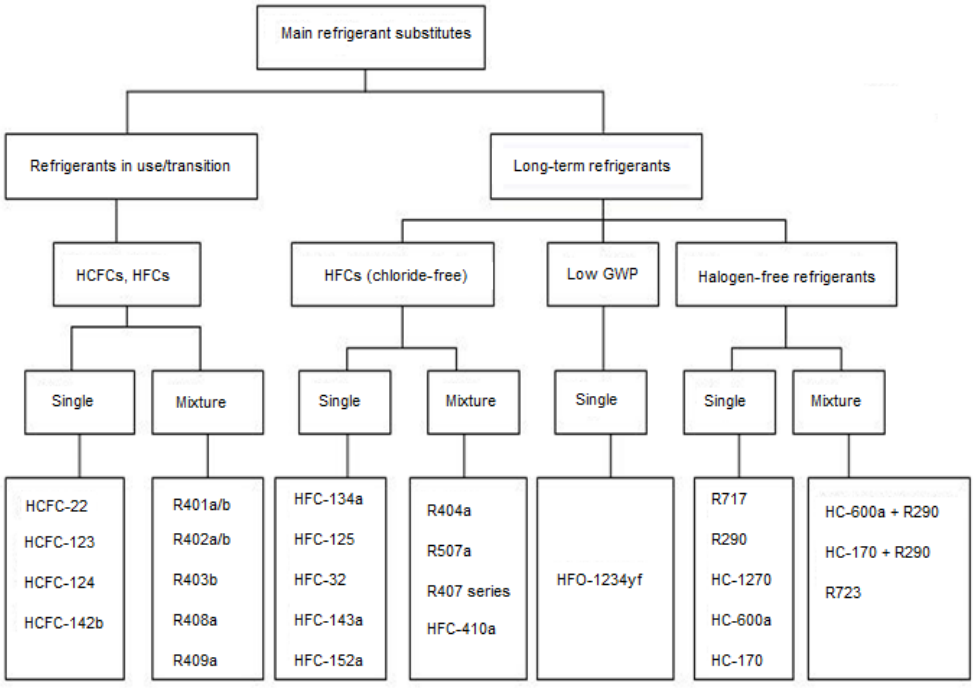
The downstream demand for refrigerants is dominated by air conditioners, refrigerators and automotive air conditioners which have the same principle of refrigeration, but the demand for refrigerant varieties varies. Older air conditioners generally use R22 as refrigerant, consuming a large amount of R22 in the industry. Newly produced air conditioners, in addition to some still using R22, mainly use R410a or R32; refrigerators use R134a as refrigerant while some have shifted to the non-fluorinated refrigerant isobutane (HC-600a); automotive air conditioners mainly use R134a.

Table 1.1-2 Output of downstream products of refrigerants in China, 2017–2021

Year	Air conditioner		Automobile	
	Output, unit	Growth rate	Output, unit	Growth rate
2017	178,615,300	24.5%	29,018,100	3.2%
2018	209,556,800	17.3%	27,827,400	-4.1%
2019	218,661,600	4.3%	25,676,700	-7.7%
2020	210,352,500	-3.8%	25,324,900	-1.4%
2021	218,357,000	3.8%	26,528,000	4.8%

Source: NBS

Figure 1.1-1 Main refrigerant substitutes in China



Source: CCM

1.1.1 Overview of HCFCs in China

China signed the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) in 1991. Since then, China has been phasing out CFCs and HCFCs in accordance with the Montreal Protocol.

Under the Montreal Protocol, in China, it's agreed to keep the production and consumption of HCFCs 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 based on the level of 2013. Furthermore, HCFCs are expected to be eliminated completely by 2040 except for special usage.

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 MEE has published production quota and domestic production quota for each HCFCs manufacturer, and use quota for each downstream enterprise every year. Specifically, for every HCFCs manufacturer, production quota puts a cap on its total sales volume; domestic 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.

Table 1.1.1-1 Production quota of HCFCs in China, 2017–2021

Year	Product	Production quota, tonne	internal production quota, tonne
2017	R22	274,279	189,017
	R141b	66,313	44,572
	R142b	22,845	17,997
	R123	2,819	432
	R124	401	139
2018	R22	274,279	189,017
	R141b	66,313	44,572
	R142b	22,845	17,997
	R123	2,819	432
	R124	401	139
2019	R22	266,821	182,804
	R141b	62,308	38,499
	R142b	17,659	11,334
	R123	2,819	432
	R124	401	139
2020	R22	224,807	135,730
	R141b	50,878	28,973
	R142b	13,890	8,574
	R123	2,819	432
	R124	401	139
2021	R22	224,807	135,730
	R141b	50,878	28,973
	R142b	13,890	8,574
	R123	2,819	432

	R124	401	139

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

The use quotas involve four industries: room air conditioning, industrial and commercial refrigeration and air conditioning, extrusion polystyrene foam and cleaning. At present, Chinese government is increasing the limitations on downstream HCFCs applications. Manufacturers had better speed up the phase-out of HCFCs and develop substitutes to facilitate industrial transformation and upgrading.

Table 1.1.1-2 Use quotas of HCFCs in China, 2021

No.	Industry	Number of companies	Product	Use quota, tonne
1	Room air conditioning	28	R22	31,726
2	Industrial and commercial refrigeration and air conditioning	12	R22	5,959
			R123	540
3	Extrusion polystyrene foam	6	R22	1,175
			R142b	716
4	Cleaning	1	R141b	280

Source: MEE

1.1.2 Overview of HFCs in China

At present, the main HFCs in China are R134a, R32, R125 and R410a. They are mainly used as refrigerants, foaming agents, fire extinguishing agents. In China, HFCs is used as substitutes for HCFCs. Yet the elimination of HFCs has been put on the agenda out of GWP concerns.

In 2016, the international community reached the Kigali Amendment to the Montreal Protocol (Kigali Amendment), aiming at reducing greenhouse gases from HFCs. By November 17, 2017, more than 20 countries had ratified the amendment which means the Kigali Amendment reached the effective condition. It will take effect on January 1, 2019.

After the Kigali Amendment taking effect, most developed countries have decreased the consumption of HFCs year by year from 2019, and by the year 2036 they will cut 85% of their annual average in the period 2011–2013. Most developing countries including China will freeze the consumption of HFCs in 2024; then from 2029, their HFCs use must go down, and by the year 2045, 80% cut of the average in 2020–2022.

The amendment will accelerate the application of safer, more environment-friendly and efficient refrigerants in China's refrigeration industry. Although China is the largest exporter of room air conditioner worldwide, if Chinese manufacturers do not transform or upgrade their production lines, they may lose market share and be outperformed by their rivals in the future.

1.2 Production and market situation of major products

Generally speaking, China's refrigerant market is in the replacement period of the third generation from the second generation: the quota of the second generation refrigerant is greatly reduced, and the third generation refrigerant is in the period of layout. Main products in China are R22, R134a, R410a, R32, R125, etc.

1.2.1 R22

1.2.1.1 Production situation

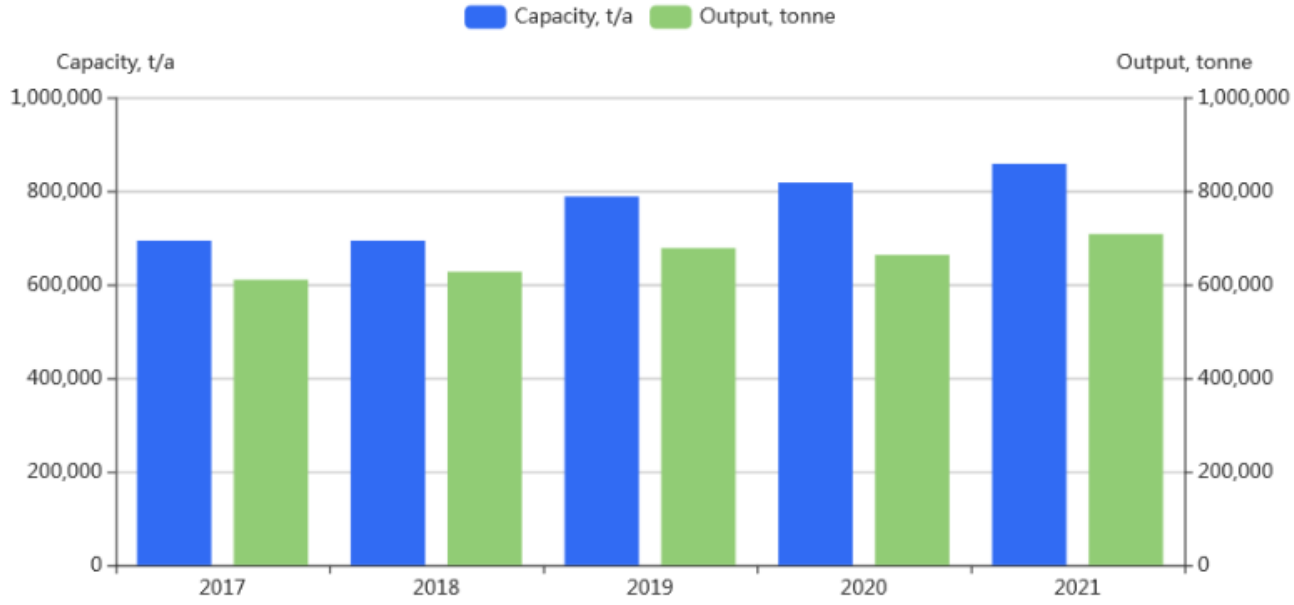
R22 is one of the major fluorine refrigerants in China.

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.

Figure 1.2.1.1-1 Capacity and output of R22 in China, 2017–2021



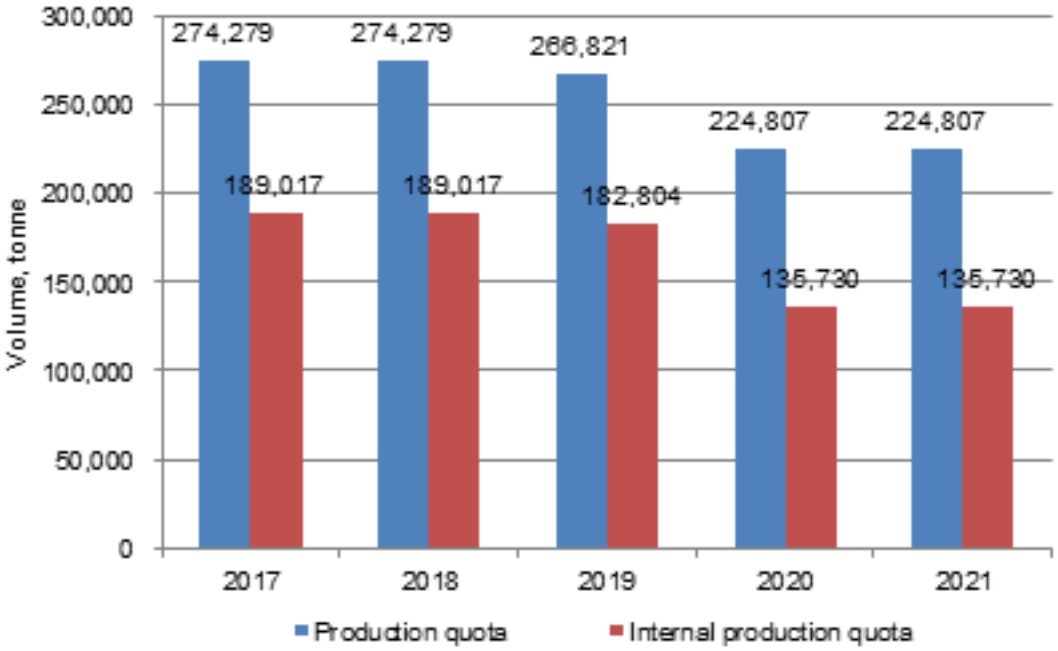
Note: 1. The data of capacity and output in 2017–2019 has been revised.
2. The capacity and output include those R22 used in non-ODS field.
Source: MEE & CCM

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%.

Figure 1.2.1.1-2 Production quota of R22 in China, 2017–2021



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 1.2.1.1-1 Active R22 manufacturers in China, 2020–2021

No.	Producer	Location	2020				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	180,000	66,228	37,670	220,000	190,000	66,228	37,670
2	Zhejiang Juhua Co., Ltd.	Zhejiang	183,000	148,600	58,682	42,457	183,000	152,500	58,682	42,457
3	Meilan Chemical Group Co., Ltd.	Jiangsu	112,000	92,000	46,484	33,327	112,000	95,200	46,484	33,327
4	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	55,000	42,400	4,856	3,661	55,000	44,000	4,856	3,661
5	Fujian Sannong New Materials Co., Ltd.	Fujian	48,000	33,000	/	/	48,000	41,300	/	/
6	Changshu 3F Zhonghao New Chemical Materials Co., Ltd.	Jiangsu	40,000	36,700	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	35,000	0	0	38,000	36,500	0	0
8	Arkema (Changshu) Fluorochemical Co., Ltd.	Jiangsu	35,000	32,500	13,245	1,051	35,000	35,000	13,245	1,051
9	Linhai Limin Chemicals Co., Ltd.	Zhejiang	32,500	20,000	10,158	4,980	32,500	23,000	10,158	4,980
10	Jiangxi Lee & Man Chemical Co., Ltd.	Jiangxi	20,000	18,000	/	/	60,000	25,000	/	/
11	Zhejiang Sanmei Chemical Co., Ltd.	Zhejiang	14,400	14,200	12,833	6,523	14,400	14,000	12,833	6,523
12	Zhejiang Pengyou Chemical Co., Ltd.	Zhejiang	10,000	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	1,700	/	/	10,000	2,100	/	/
Total			**817,900**	**663,100**	**224,807**	**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

1.2.1.2 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 outbreak of COVID-19 at home and abroad. Specifically:

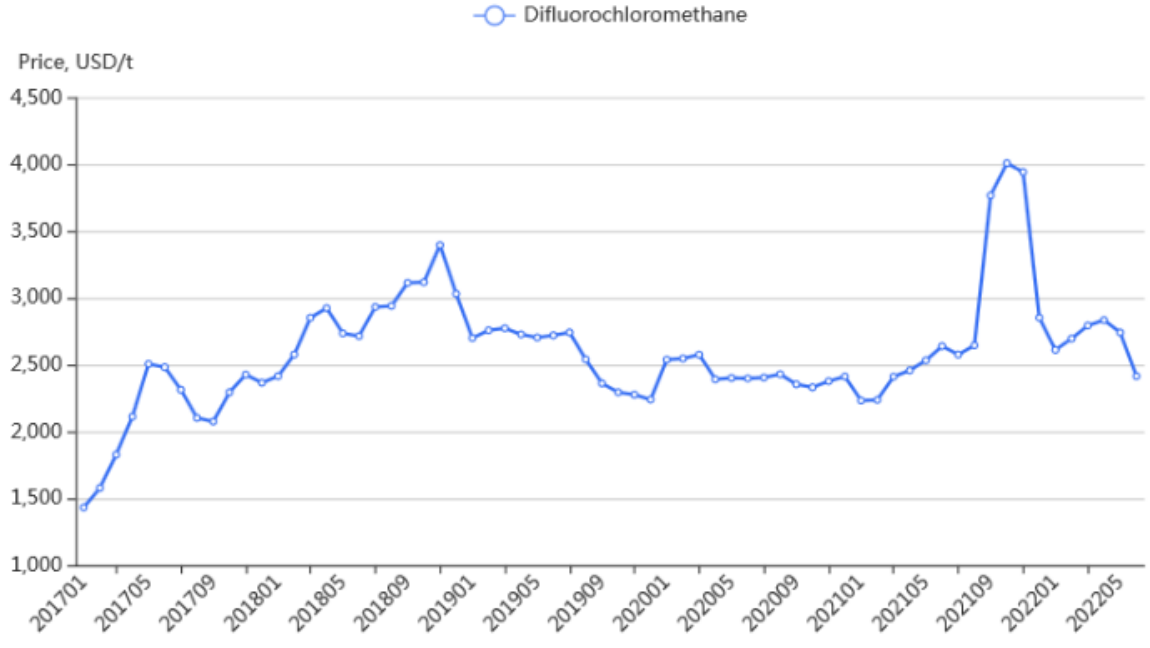
- In Q1, the price remained stable after rising, as the prices of raw material AHF and chloroform were quite stable. At the same time, affected by the COVID-19 outbreak, production resumption was delayed, and transportation control was severe. As a result, the market supply was tight, supporting the 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 H1 2022, R22 price rose in a narrow range before falling back. The price peaked in April, as supply shrank because of blocked transportation in some provinces due to COVID-19 resurgence. Then the price went down with raw material prices.

Figure 1.2.1.2-1 Ex-works price of R22 in China, Jan. 2017–June 2022

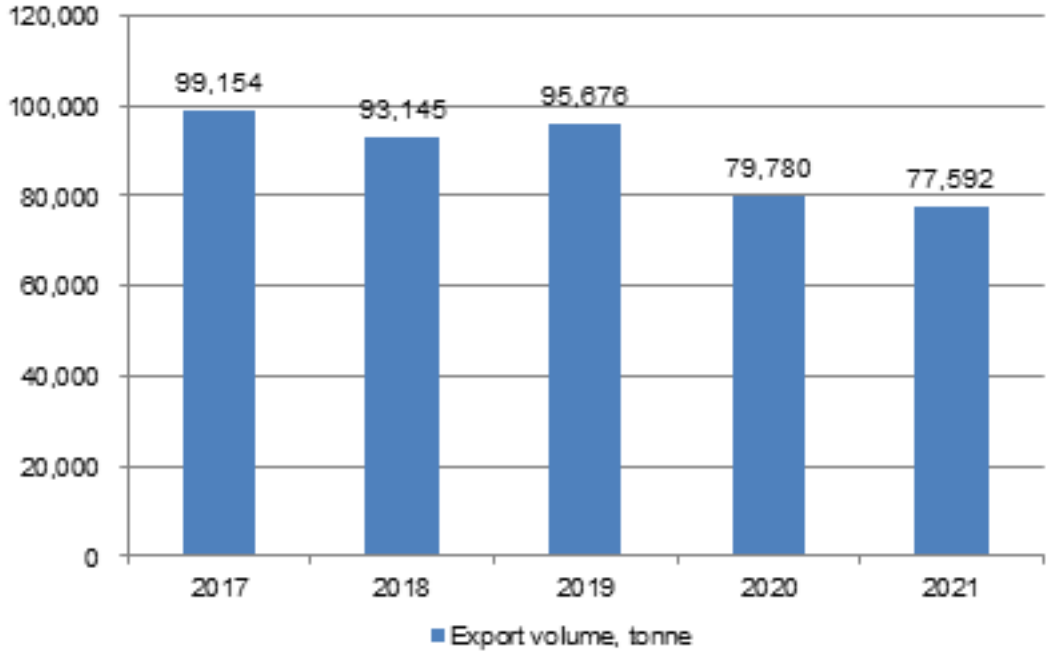


Source: CCM

1.2.1.3 Export

In 2017–2021, China R22 export volume fluctuated, but it showed a downward trend in general, falling from 99,154 tonnes in 2017 to 77,592 tonnes in 2021.

Figure 1.2.1.3-1 Export volume of R22 in China, 2017–2021



Note: The data of 2018 has been revised.
Source: China Customs & CCM

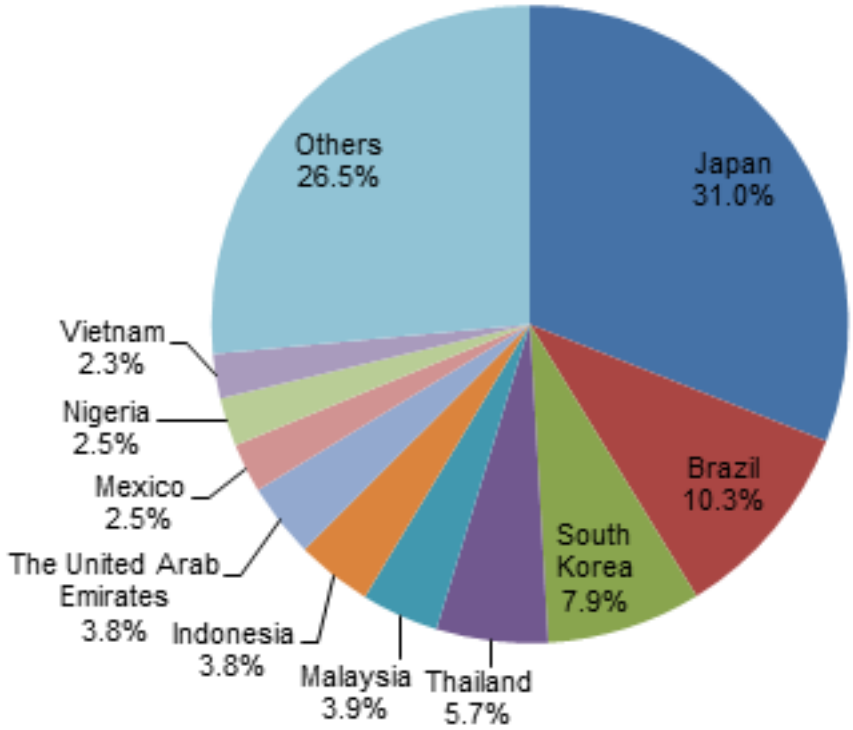
Table 1.2.1.3-1 Exports of R22 in China, 2017–2021

Year	Export volume, tonne	Export value, USD	Export price, USD/t
2017	99,154	182,755,217	1,843
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

Source: China Customs & CCM

In 2021, Japan, Brazil, South Korea and Thailand were the top four export destinations of R22 from China by volume, with combined export volume of 42,485 tonnes, about 54.9% of the total export volume.

Figure 1.2.1.3-2 Top ten export destinations of R22 from China by volume, 2021



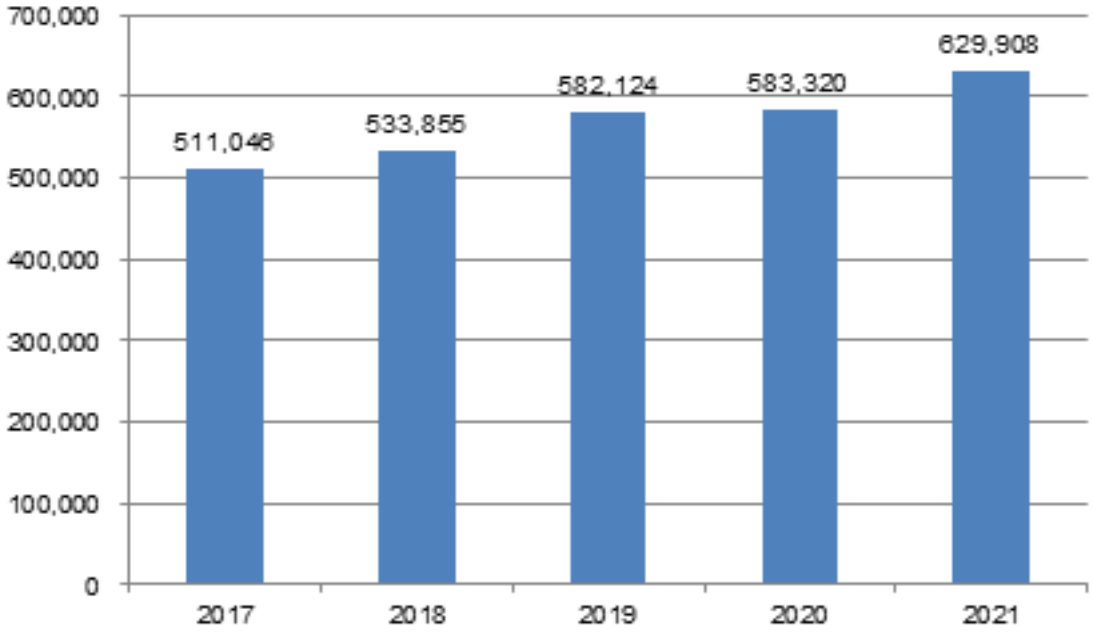
Source: China Customs & CCM

1.2.1.4 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) and 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.

Figure 1.2.1.4-1 Apparent consumption of R22 in China, 2017–2021



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, boosting the total consumption of R22.

Table 1.2.1.4-1 Consumption of R22 in non-ODS field in China, 2017–2021

Year	Consumption volume, tonne
2017	322,029
2018	344,838
2019	399,320
2020	447,590
2021	494,178

Source: CCM

Table 1.2.1.4-2 Consumption quota of R22 in ODS field in China, 2017–2021

Year	Consumption quota, tonne			
	Room air conditioner	Industrial and commercial refrigeration and air conditioning	Extrude polystyrene foam	Others
2017	58,154	8,542	3,852	118,469
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

Source: MEE & CCM

Table 1.2.1.4-3 R22 quota allocation for room air conditioner industry, 2021

Company	Use quota, tonne	Percentage
Gree Group	11,452	36.1%
Media Group	8,050	25.4%
Zhigao Group	2,797	8.8%
TCL Group	2,251	7.1%
Haier Group	2,062	6.5%
AUX Group	1,300	4.1%
Galanz Group	1,200	3.8%
Haixin Group	1,000	3.2%
Others	1,614	5.1%
Total	**31,726**	*/*

Source: MEE

Table 1.2.1.4-4 R22 quota allocation for refrigeration and air conditioning in industrial and commercial application, 2021

Company	Use quota, tonne	Percentage
Gree Group	2,334	39.2%
Media Group	1,990	33.4%
Haier Group	777	13.0%
Others	858	14.4%
Total	**5,959**	*/*

Source: MEE

1.2.2 R134a

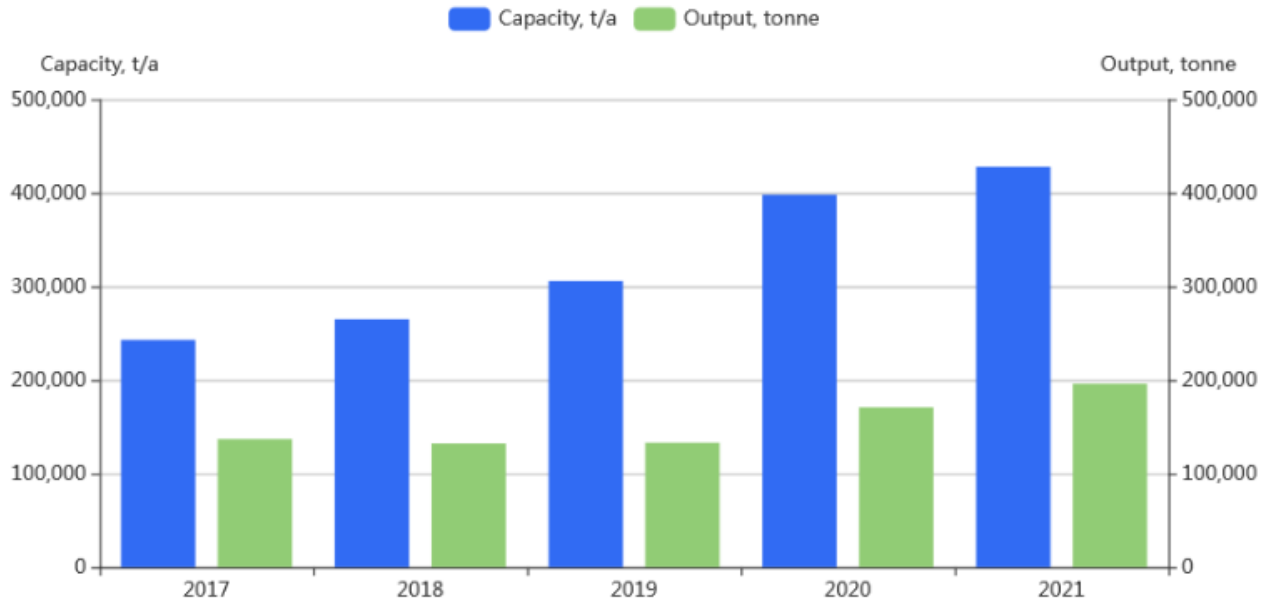
1.2.2.1 Production situation

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 2020–2021.

Figure 1.2.2.1-1 Capacity and output of R134a in China, 2017–2021



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.

Table 1.2.2.1-1 Active R134a manufacturers in China, 2020–2021

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2021	2020	2021	2020
1	Zhejiang Juhua Co., Ltd.	Zhejiang	68,000	68,000	61,200	56,600
2	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	65,000	65,000	44,300	54,500
3	Inner Mongolia Yonghe Fluorochemical Co., Ltd.	Inner Mongolia	50,000	20,000	15,200	8,500
4	Sinochem Modern Environmental Protection Chemicals (Xi'an) Co., Ltd.	Shaanxi	40,000	40,000	14,000	11,000
5	Jiangsu Bluestar Green Technology Co., Ltd.	Jiangsu	40,000	40,000	11,000	8,000
6	Meilan Chemical Group Co., Ltd.	Jiangsu	30,000	30,000	11,000	9,000
7	Shandong Hua'an New Material Co., Ltd.	Shandong	30,000	30,000	9,000	7,000
8	Zibo Feiyuan Chemical Co., Ltd.	Shandong	30,000	30,000	7,500	2,000
9	Shaanxi Sinochem Lantian Chemical Technology New Material Co., Ltd.	Shaanxi	30,000	30,000	5,000	1,500
10	Jiangxi Zhongxin Artsen New Materials Co., Ltd.	Jiangxi	20,000	20,000	6,000	5,000
11	Dongyue Group Ltd.	Shandong	15,000	15,000	8,000	6,400
12	Ruyuan Dongyangguang Fluorine Co., Ltd.	Guangdong	10,000	10,000	3,800	1,500
Total			**428,000**	**398,000**	**196,000**	**171,000**

Source: CCM

1.2.2.2 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.

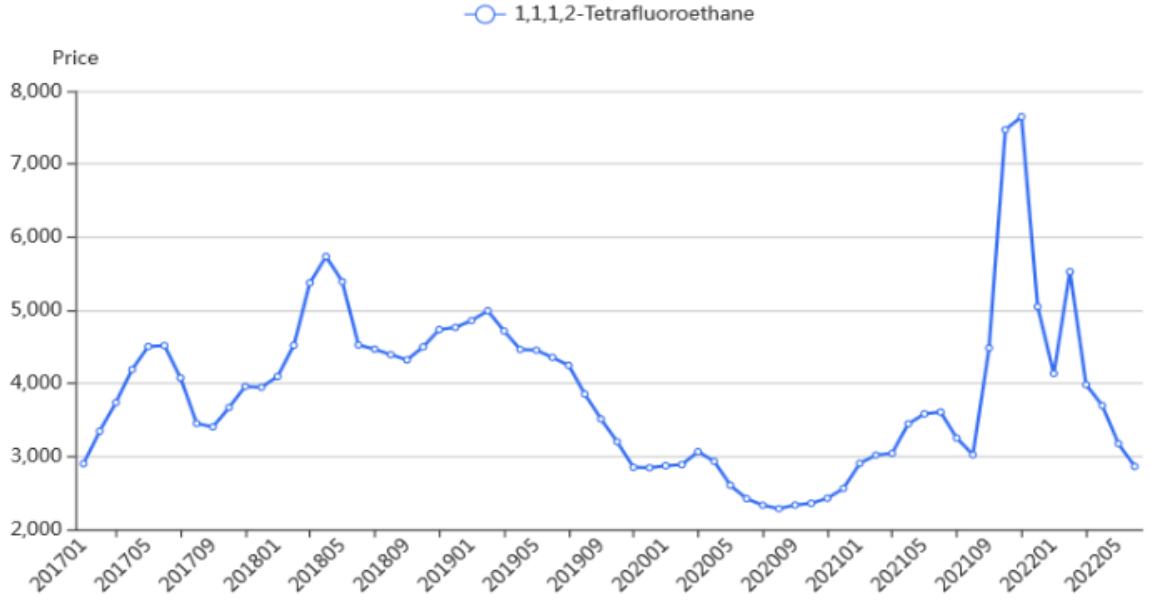
R134a manufacturers had scrambled to expand supply with the increasing price, and the operating rate continued rising. Then there appeared oversupply of R134a. Price of R134a has fallen sharply thereafter. At the same time, the falling price of AHF further reduced R134a price to USD 2,846/t in Dec. 2019.

Generally speaking, R134a price was at a low level in 2020. 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 new 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., a month-on-month decrease of 34.0%.

In Jan. 2022, R134a price continued to fall, losing support from the production cost and demand. Although there was a temporary rebound in Feb., the price soon returned to the downtrend with weak production cost support and slumping demand.

Figure 1.2.2.2-1 Ex-works price of R134a in China, Jan. 2017–June 2022



Source: CCM

1.2.3 R32, R125 and R410a

1.2.3.1 Production situation

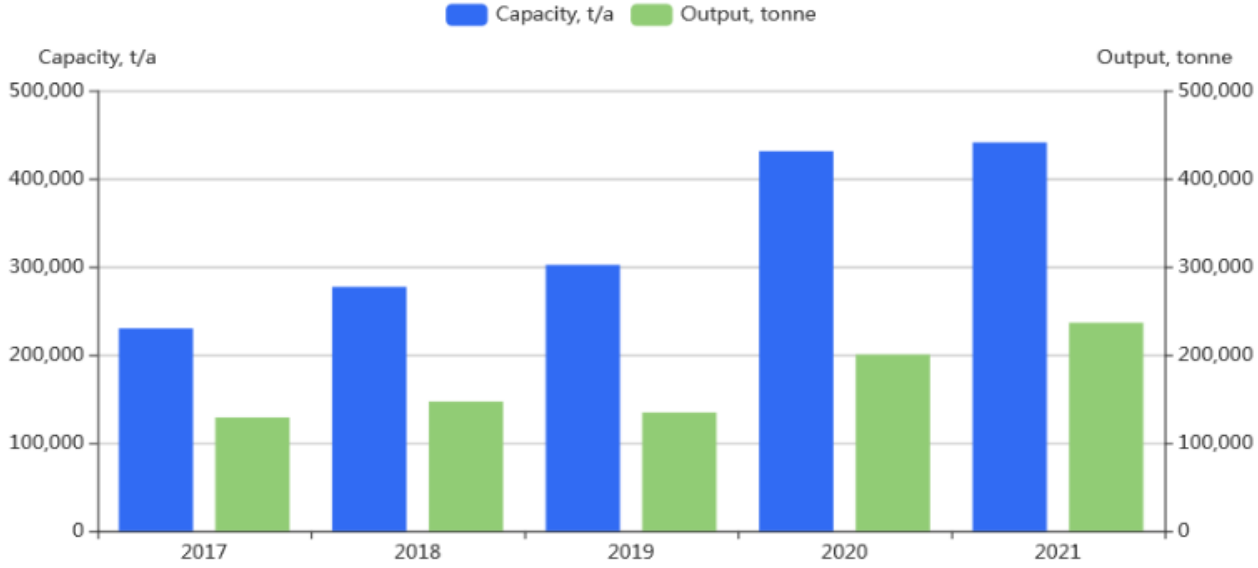
- R32

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.

Figure 1.2.3.1-1 Capacity and output of R32 in China, 2017–2021



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.

Zhejiang Juhua Co., Ltd. was the largest R32 producer in China in 2021, with the capacity and output of 100,000 t/a and 80,900 tonnes, accounting for 22.7% and 34.2% of the domestic totals respectively. Dongyue Group Ltd. came in second.

Table 1.2.3.1-1 Main active R32 manufacturers in China, 2020–2021

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2021	2020	2021	2020
1	Zhejiang Juhua Co., Ltd.	Zhejiang	100,000	100,000	80,900	69,000
2	Dongyue Group Ltd.	Shandong	60,000	60,000	41,000	38,000
3	Meilan Chemical Group Co., Ltd.	Jiangsu	50,000	50,000	7,000	5,000
4	Shandong Hua'an New Material Co., Ltd.	Shandong	50,000	50,000	5,500	5,000
5	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	40,000	40,000	26,500	25,300
6	Ruyuan Dongyangguang Fluorine Co., Ltd.	Guangdong	30,000	30,000	25,300	18,900
7	Zibo Feiyuan Chemical Co., Ltd.	Shandong	30,000	30,000	18,000	16,000
8	Luxi Chemical Group Co., Ltd.	Shandong	10,000	10,000	7,000	6,000
9	Linhai Limin Chemicals Co., Ltd.	Zhejiang	10,000	10,000	7,000	5,000
10	Shanghai 3F New Materials Co., Ltd.	Shanghai	10,000	10,000	6,000	5,000
11	Jiangxi Lee & Man Chemical Co., Ltd.	Jiangxi	10,000	10,000	4,000	2,600
12	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	10,000	/	3,400	0
Others			31,000	31,000	4,800	4,500
Total			**441,000**	**431,000**	**236,400**	**200,300**

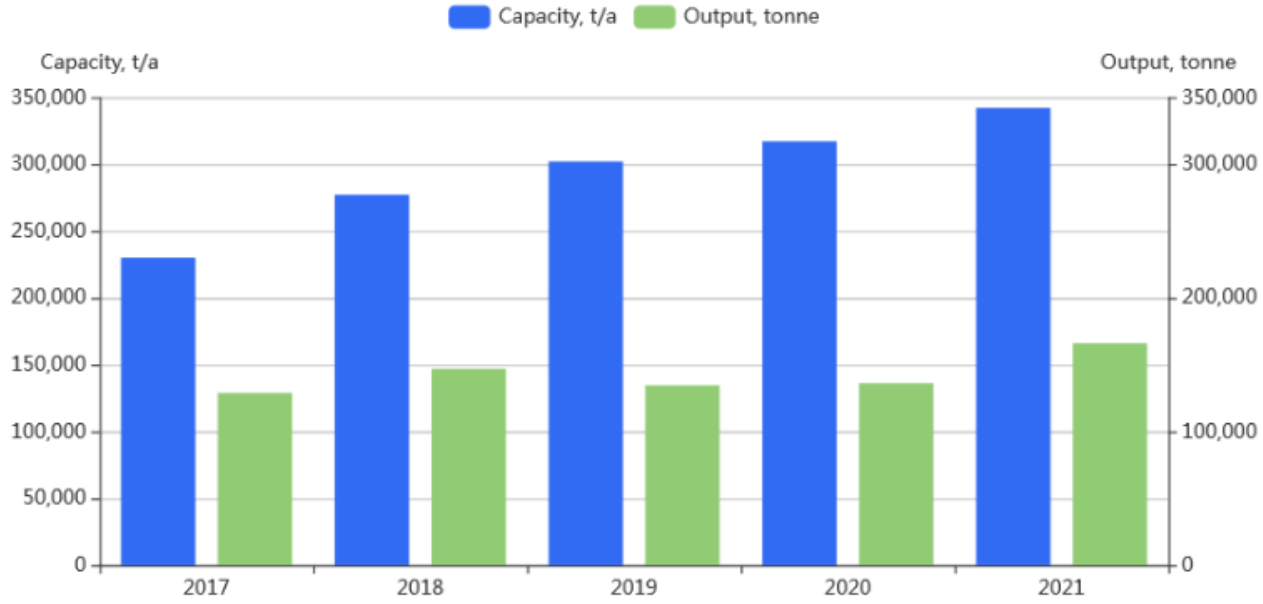
Note: 1. The reason for Meilan Chemical Group Co., Ltd.'s low operating rate was that its subsidiary Taixing Meilan New Materials Co., Ltd. (with 40,000 t/a capacity) was still in trial production.
2. The reason for Shandong Hua'an New Material Co., Ltd.'s low operating rate was that the production line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

Figure 1.2.3.1-2 Capacity and output of R125 in China, 2017–2021



Source: CCM

In 2021, most R125 producers concentrated in Shandong and Zhejiang provinces; capacity in the two provinces made up 40.4% and 32.7% 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 14,500 tonnes in 2021, accounting for 17.0% and 8.7% 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 32,700 tonnes respectively in 2021.

Table 1.2.3.1-2 Main active R125 manufacturers in China, 2020–2021

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2021	2020	2021	2020
1	Dongyue Group Ltd.	Shandong	58,000	33,000	14,500	12,000
2	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	52,000	52,000	32,700	24,900
3	Zhejiang Juhua Co., Ltd.	Zhejiang	50,000	50,000	43,600	46,000
4	Sinochem Environmental Protection Chemical Co., Ltd.	Jiangsu	30,000	30,000	9,000	6,000
5	Shandong Hua'an New Material Co., Ltd.	Shandong	30,000	30,000	9,400	7,600
6	Ruyuan Dongyangguang Fluorine Co., Ltd.	Guangdong	20,000	20,000	17,600	11,100
7	Zibo Feiyuan Chemical Co., Ltd.	Shandong	20,000	20,000	8,000	5,000
8	Arkema Daikin Advanced Fluorochemicals (Changshu) Co., Ltd.	Jiangsu	20,000	20,000	7,000	6,000
9	China Fluoro Technology Co., Ltd.	Shandong	20,000	20,000	6,000	4,000
10	Meilan Chemical Group Co., Ltd.	Jiangsu	10,000	10,000	6,000	5,000
11	Luxi Chemical Group Co., Ltd.	Shandong	10,000	10,000	4,000	2,000

Others	22,000	22,000	8,200	6,500
Total	**342,000**	**317,000**	**166,000**	**136,100**

Source: CCM

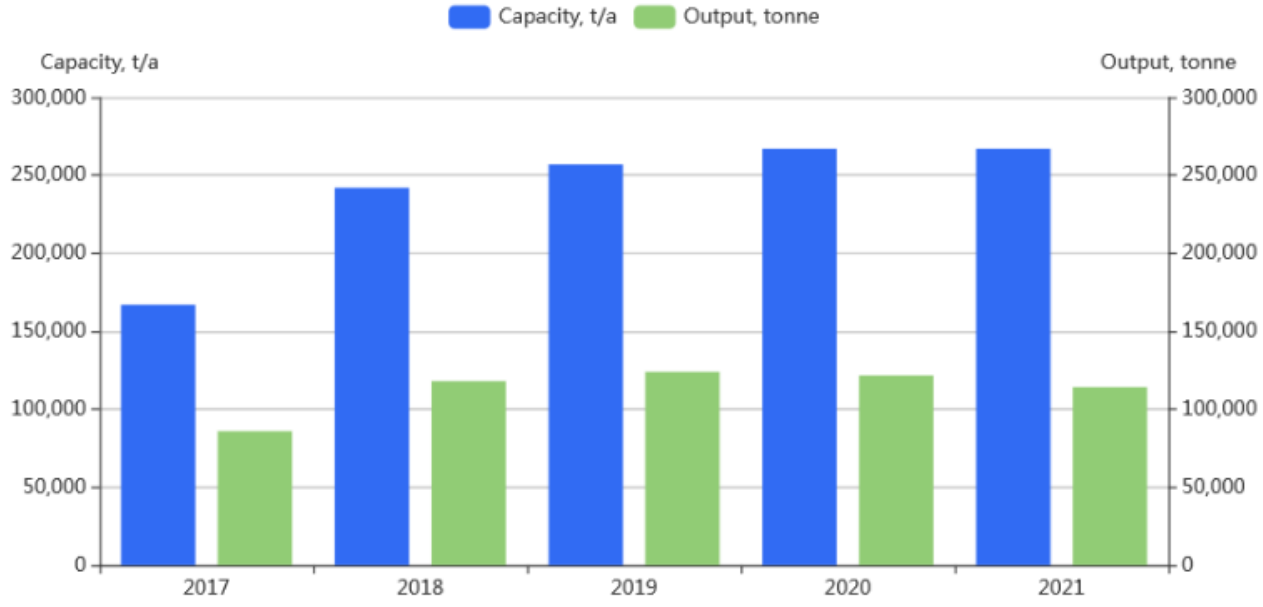
- R410a

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.

Figure 1.2.3.1-3 Capacity and output of R410a in China, 2017–2021



Source: CCM

Table 1.2.3.1-3 Main active R410a manufacturers in China, 2020–2021

No.	Producer	Location	Capacity, t/a		Output, tonne	
			2021	2020	2021	2020
1	Zhejiang Juhua Co., Ltd.	Zhejiang	50,000	50,000	25,000	23,000
2	Dongyue Group Ltd.	Shandong	50,000	50,000	20,000	20,000
3	Zhejiang Sanmei Chemical Industry Co., Ltd.	Zhejiang	30,000	30,000	7,000	7,500

4	Ruyuan Dongyangguang Fluorine Co., Ltd.	Guangdong	20,000	20,000	13,000	13,400
5	Luxi Chemical Group Co., Ltd.	Shandong	20,000	20,000	6,000	8,000
6	Zhejiang Yonghe Refrigerant Co., Ltd.	Zhejiang	15,000	15,000	3,200	8,000
7	Meilan Chemical Group Co., Ltd.	Jiangsu	12,000	12,000	10,000	5,000
8	Zibo Feiyuan Chemical Co., Ltd.	Shandong	10,000	10,000	5,000	5,000
9	Shandong Hua'an New Material Co., Ltd.	Shandong	10,000	10,000	5,000	5,000
10	Linhai Limin Chemicals Co., Ltd.	Zhejiang	10,000	10,000	3,000	4,800
11	Shanghai 3F New Materials Co., Ltd.	Shanghai	5,000	5,000	2,000	2,000
Others			35,000	35,000	15,000	20,000
Total			**267,000**	**267,000**	**114,200**	**121,700**

Source: CCM

1.2.3.2 Price

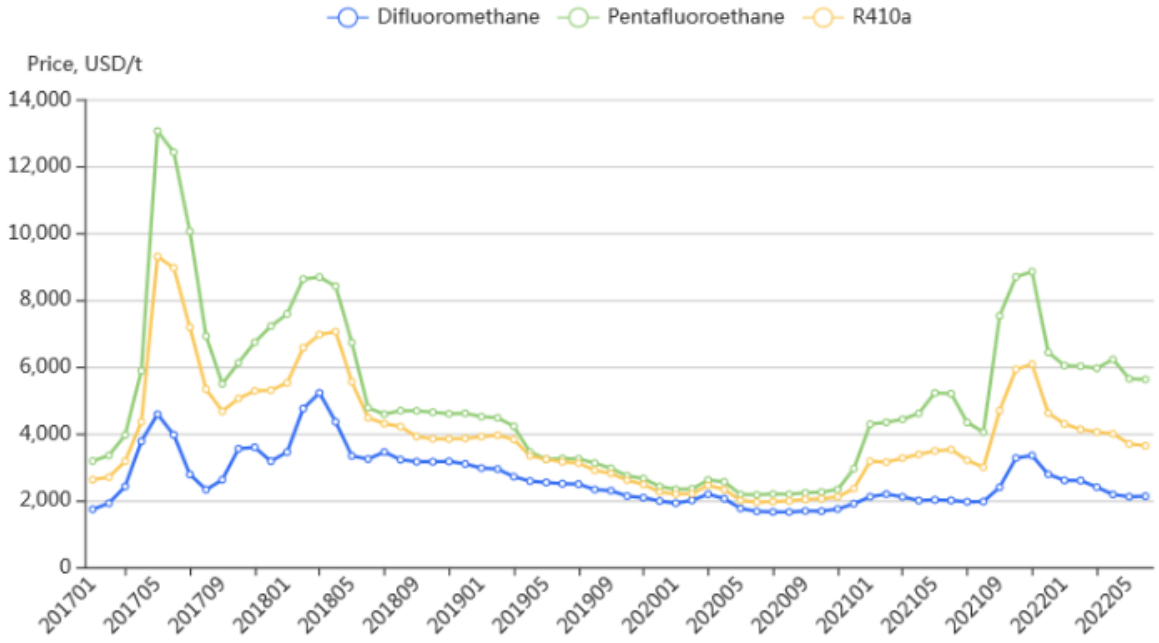
R410a is a mixture of R125 and R32. It is also an important refrigerant used in the home air-conditioning industry, whose price changes with the price of its raw materials.

The price of R410a dropped from USD7,049/t in April 2018 to USD2,252/t in Dec. 2019, which is due to 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.

Figure 1.2.3.2-1 Ex-works price of R32, R125 and R410a in China, Jan. 2017–June 2022



Source: CCM

1.2.4 Situation of other major products

- Foam beaters

1,1-dichloro-1-fluoroethane (R141b) is widely used as a substitute for trichlorofluoromethane (R11) as a rigid PU foam beater, and a substitute for 1,1,2-trichloro-1,2,2-trifluoroethane (R113) as a cleaning agent. It can also be used as a refrigerant.

With an ODP of 0.01, R141b can destroy the ozone layer. The MEE drew up the first phase-out plan of HCFCs (R141b included) in 2010, which required that local governments should control new construction, transformation and extension of chlorine-containing HCFCs production facilities from the end of 2010 in China. Besides, the consumption of R141b was banned in refrigerators, freezers, refrigerated containers and small household appliances in 2015.

There are some substitutes for R141b in the domestic market, including cyclopentane, 1,1,1,3,3-pentafluoropropane (R245fa, patent of Honeywell) and 1,1,1,3,3-pentafluorobutane (R365mfc, patent of Solvay S.A.). R245fa is a new environment-friendly foam beater, once monopolized by developed countries.

Now, many domestic refrigerator manufacturers focus on the blending foaming technology of R245fa & cyclopentane, R365mfc & cyclopentane and R365mfc & cyclopentane & R245fa. The blending foam beater is cheaper and has better performances compared with R245fa or R365mfc alone.

- Mixed refrigerants

Representative mixed refrigerants include R407c, R410a, R417a, R422d, DYR-3, DYR-5, R425a and RS-44. These refrigerants have zero ODP, but high GWP which could bring about severe greenhouse effect. Right now, popular mixed refrigerants are R407c, R410a, R417a, R404a, R507.

R407c (a ternary non-azeotrope consisting of R32, R125 and R134a) and R410a (a binary non-azeotrope consisting of R32 and R125) are the mainstream refrigerant mixture substitutes in the world, and R410a is used as a alternative to R22 at present.

R417a (a ternary non-azeotrope consisting of R134a, R125 and R600) and R404a (a ternary non-azeotrope consisting of R134a, R125 and R143). Both their ODP are zero, so R417a and R404 are environmentally friendly refrigerants that does not destroy the atmospheric ozone layer. R417a is mainly used in the heat pump and air conditioning aftermarket to replace R22, and R404a is mainly used in low to medium temperature refrigeration systems to replace R22 and R502.

R507 (a binary non-azeotrope consisting of R143 and R125), has zero ODP, is mainly used in low to medium temperature refrigeration systems to replace R22 and R502.

2 Forecast trend

- HCFCs

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, R22 will be gradually replaced by other eco-friendly refrigerants and the demand for it will decrease. However, the output of R22 as a raw material will keep increasing to support the production of PTFE, HFP and other new refrigerants.

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 switch to its substitutes. However, it is predicted that the total consumption of R22 will surge rather than fall, bolstered by the demand from downstream sectors including PTFE and HFP.

R141b will be a thing of the past ahead of R22. R141b was once the main foam beater in China before 2009. But now, both the production quota and consumption of R141b decreased.

- HFCs

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 major refrigerants and its substitutes are just at early development stage.

Other than a small number of newly-produced air conditioners that still use R22, the third-generation refrigerant R410a or R32 are 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 is 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 conditioners.

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.

- HFOs

2,3,3,3-Tetrafluoropropene (R1234yf) and 1,3,3,3-Tetrafluoropropene (R1234ze) are the fourth-generation fluorinated refrigerants to replace HCFCs. Both of them can be used as refrigerant or foam beater. They have excellent performance but cost much. R1234yf is considered to be the alternative refrigerant to R134a applied in automobiles, while R1234ze is considered to be the alternative foam beater to R141b applied in refrigerators and freezers.

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. Up to 2021, there were four Chinese manufacturers that can produce R1234yf, with total capacity of 22,500 t/a. But Zhejiang Huanxin Fluoro Material Co., Ltd., with independent intellectual property rights, has a 3,000 t/a R1234yf refrigerant project under construction.

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.

Table 2-1 Situation of the production of R1234yf in China, 2021

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

Source: CCM

- Close-to-natural refrigerants

Representative close-to-natural refrigerants include R290 and R161, both of which are environmentally friendly and have zero ODP and GWP. Such kind of refrigerants is ideal substitute for R22. However, there is a security problem—the close-to-natural refrigerants are flammable and explosive. Besides, if they are to be applied to current air conditioner systems, those systems must be modified and adjusted.

R290 is also applied widely in the downstream air conditioner industry. Gree Electric Appliances, Inc. of Zhuhai has already developed an energy-efficient air conditioner model which uses R290 as the refrigerant. And this air conditioner overcame the security problem, obtaining VDE Certificate from Germany. Besides, many air conditioning manufacturers have established R290 production lines, such as Midea, Haier, Gree, etc. Therefore, research on substitute products for R22 is not only related to refrigerants development, but also related to the upgrade of downstream air conditioner industry.

- Natural refrigerants

The representative natural refrigerant is CO_2. Natural refrigerants are more environmentally friendly, safe, but low in efficiency. Some foreign countries have used natural refrigerant CO_2 replacement technology; for example, Japan has successfully used CO_2 in automobile air conditioners. However, the technology isn't mature in China.

3 Conclusions

Production of fluorite and anhydrous hydrogen fluoride (AHF) in China is restricted by policies. After industry integration, fluorine resources will be finally controlled by top enterprises. As a result, the prices of fluorite and AHF will keep rising in the long run and these two resources will become harder to obtain in China.

In the whole fluorine chemical industry chain, domestic enterprises are competitive in the lower-end products, while products with high additional value and high demand for deep processing and technology are basically controlled by foreign counterparts. So it is recognized that investing in the downstream industries, such as green fluorine refrigerants and fluorine polymers is a good way to utilize China's fluorite resources.

At present, China has become the largest country in the production, consumption and export of HCFCs and HFCs. With stricter environmental inspections going on, the refrigerant industry has seen higher concentration ratio and greater integration into a few larger enterprises especially state-owned ones.

Chinese refrigerant enterprises are far behind foreign multinational enterprises in the R&D of new-generation refrigerants with low GWP. The core patents are all held by the foreign ones, which has already seriously restricted the R&D and application of the next generation of domestic refrigerants.

With the transfer of international refrigerant capacity to China, the cooperation between Chinese and multinational companies increase. The multinationals take full advantages of their technology and market to make Chinese refrigerant enterprises their OEMs.

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