



Low-Carbon Green

– The Sustainable Development Road of China's Paint Industry

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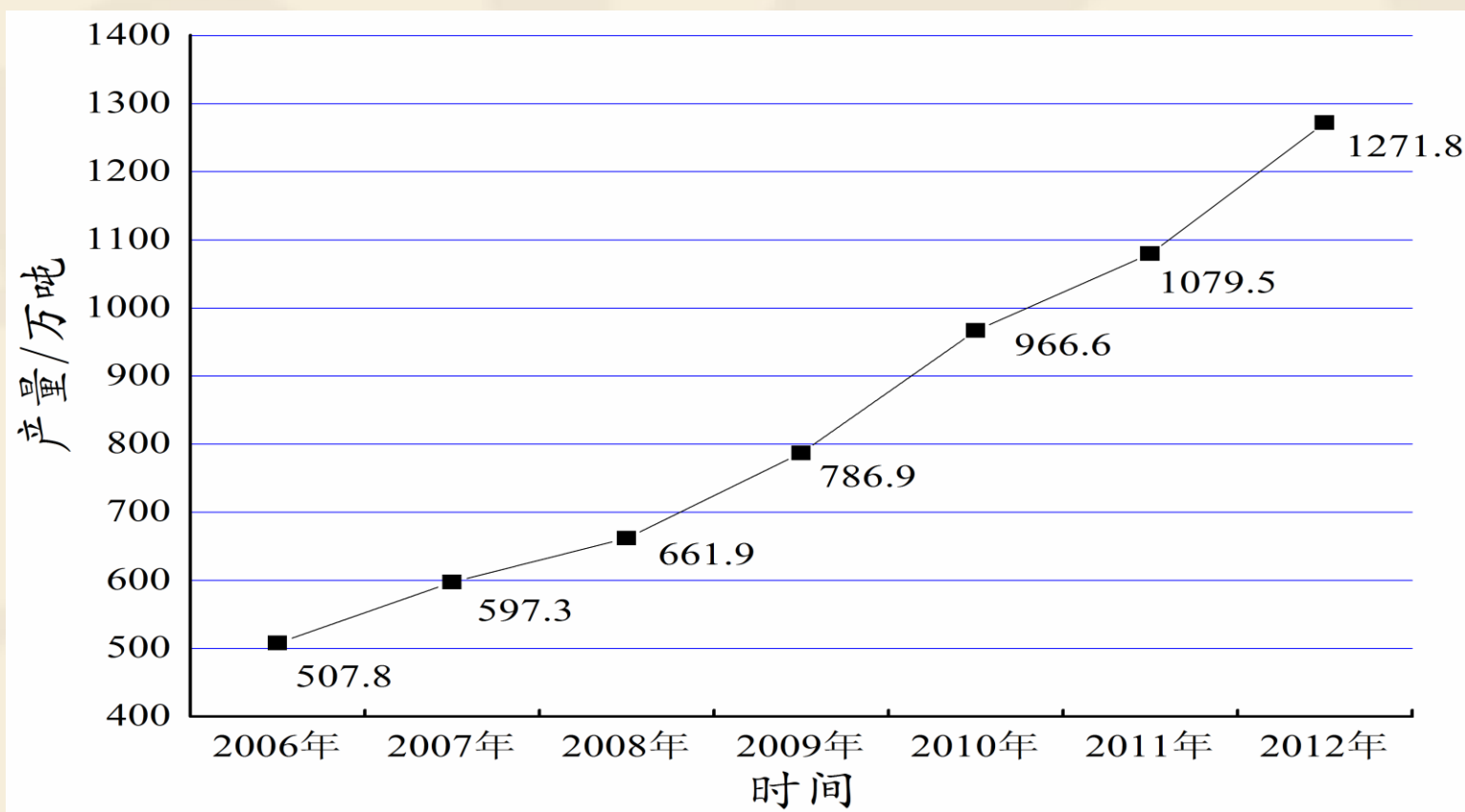
Main content

- ❖ **Status quo of China's paint and pigment industry**
- ❖ **Environmental pressure and challenges facing China's paint industry**
- ❖ **Future development road (direction) of China's paint industry**

China is a major producer of paints and pigments

- ❖ **China's paint industry has developed rapidly. Its output and sales of paints rank first in the world. In 2011, its annual output topped 10 million tons, and in 2012, its paint output was 12.718 million tons**
- ❖ **China is also the largest producer of pigments in the world.**
- ❖ **Although China has numerous paint and pigment manufacturers, their scale is generally small, and the industry concentration is low; what is more, the technological innovation strength is relatively weak**
- ❖ **The product variety and structure is unreasonable. Varieties which feature low quality and price and have a bad influence on environment still occupy a larger market share, while those with high performance, functionality and environmental safety are relatively less**

China's paint output increases rapidly



China's annual paint output since the 11th Five-Year Plan period

China's paint output value in the last five years

Year	Statistical number of enterprises	Total industrial output value (in current price)		Sales value (in current price)	
		Amount / 10,000 yuan	Year-on-year growth / %	Amount / 10,000 yuan	Year-on-year growth / %
2008	2149	15 508 280	18.1	15 201 476	19.1
2009	2571	18 359 059	15.8	17 912 836	19.1
2010	2749	23 245 914	25.7	22 825 196	26.3
2011	1772	27 297 631	25.6	26 809 728	25.7
2012	1858	29 346 033	12.4	28 859 758	11.8

Source: Annual Report on Paint Industry 2012, Editorial department of Paint and Coatings Industry

Output and percentage of China's major paint varieties in 2007~2012

Variety	2007年		2008年		2009年		2010年		2011年		2012年	
	Output / 10,000 t	Percentage	Output / 10,000 t	Percentage	Output / 10,000 t	Percentage	Output / 10,000 t	Percentage	Output / 10,000 t	Percentage	Output / 10,000 t	Percentage
Architectural coating	239.6	35.6	240.0	34.3	276.0	34.8	378.8	38.6	394.0	35.8	467	36.1
Automobile coating	44.5	6.6	48.0	6.9	67.2	8.5	88.2	9.0	99.0	9.0	115	8.9
Industrial protective coating	145.2	21.7	160.0	22.8	176.0	22.2	220.5	22.5	282.5	25.7	334	25.9
Furniture coating	102.1	15.2	102.0	14.6	107.1	13.5	118.6	12.1	121	11.0	138	10.7
Coil coating	14.4	2.2	15.0	2.2	16.5	2.1	18.6	1.9	22	2.0	29	2.2
Powder coating	68.0	11.0	73.9	9.7	83.0	10.5	88.2	9	99	9.0	110	8.5
Other coatings	56.2	7.5	61.1	9.5	67.2	8.4	67.1	6.9	82.5	7.5	102	7.7
Total	670.0	100	700.0	100	793.0	100	980.0	100	1100.0	100	1292	100.0

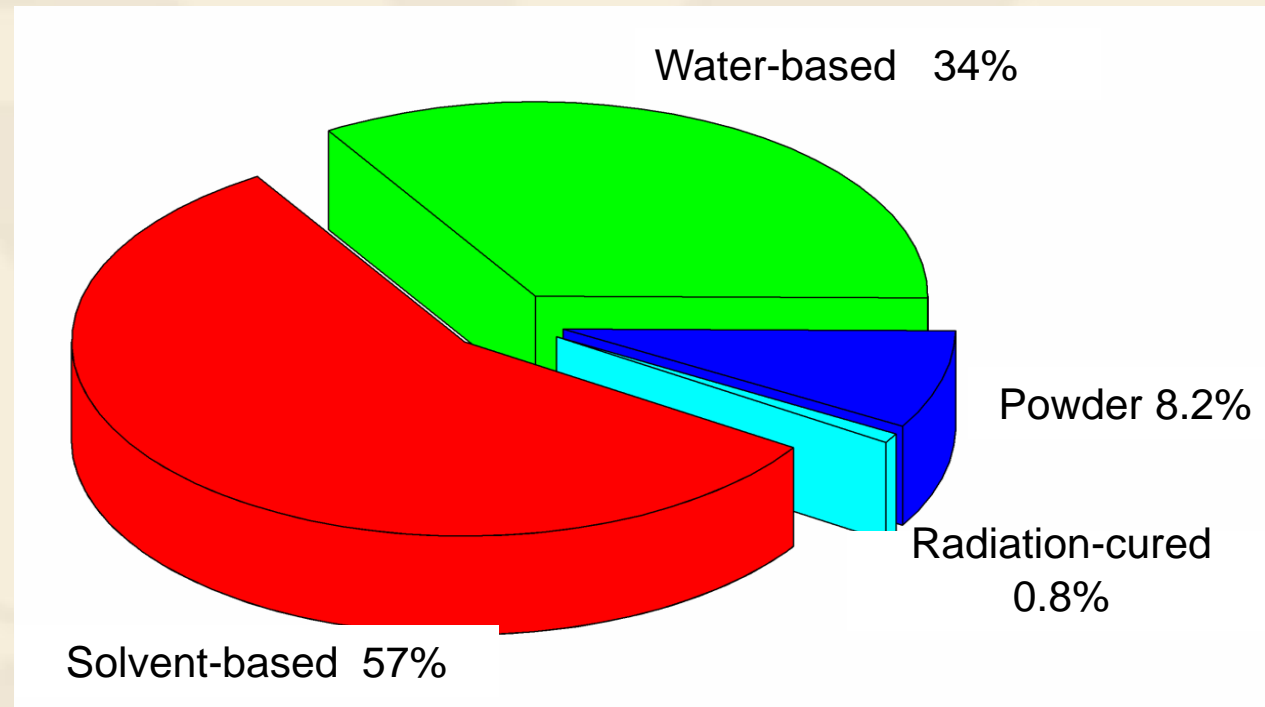
Source: Annual Report on Paint Industry 2012, Editorial department of Paint and Coatings Industry

China's water-based coating output in 2012 (estimated)

Main varieties	Output / 10,000 t	Percentage of water-based coatings (estimated)	Output of water-based coatings / 10,000 t (estimated)
Architectural coating	467	80	374
Automobile coating	115	25	29
Industrial protective coating	334	4	13
Furniture coating	138	5	7
Coil coating	29	0	/
Powder coating	110	/	/
Other coatings	102	15	15
Total	1292	100.0	438

Note: Except architectural coating, other varieties of water-based coatings have no formal statistical data, and the above-mentioned relevant data are estimated

China's paint product structure in 2012



In 2012, China's output of water-based coatings (mainly architectural coating) was estimated to be 4.38 million tons (accounting for about 34%), and that of solvent-based coatings was estimated to be 7.35 million tons (accounting for about 57.0%).

Total VOC of China's paint and application industry (estimated value)

As for solvent-based coatings, the average organic solvent content is about 55%, and becomes about 70% after application dilution; as for water-based coatings, the average organic solvent content is 5%

Then the total organic solvent content (VOC) of domestic paint products is approximately:

$$12.92 \times (57\% \times 70\% + 34\% \times 5\%) = 5.375 \text{ million tons}$$

The average VOC of China's paint products is about 42% (~550 g/l), while that of industrially developed countries' paint products is below 420 g/l. The organic solvents consumed by China's paint industry each year account for 25%-30% of the country's total solvent consumption.

Reduce VOC, develop and produce environment-friendly paints

Status quo of China's paint application

Currently, in the paint application field in China, only a few industries (such as coil, car body) have advanced application process and equipment level to absorb the released organic solvents and recycle them for combustion treatment. In most industries, the organic solvents released during the paint application process are directly emitted into the atmosphere.

China is the No.1 paint producer as well as the country emitting the largest amount of VOC into the atmosphere.

Toxicity of VOC (Volatile Organic Compounds)

- ❖ Different organic solvent have different degrees of toxicity (inhalation is the most harmful one)

Neurotoxicity

Blood toxicity

Liver and kidney toxicity

Skin and mucous membrane irritation

Reproductive genetics

- ❖ 3 hazards of VOC released into air

Stimulate eyes

Form particles in the atmosphere

Photochemical reaction, form ozone toxic oxide, which brings secondary pollution

VOC+NOX-----Surface ozone (O₃)

It is vital to reduce VOC and develop environmental-friendly coatings!

Status quo of China's titanium dioxide pigment industry

- ❖ In 2012, the capacity reached 2.6 million tons, the actual output topped 1.8 million tons, the domestic apparent consumption was nearly 1.7 million tons, and the paint industry consumed nearly one-third
- ❖ The sulfuric acid method was dominant, and the chlorination method only accounted for 1%
- ❖ The facility scale has been greatly improved, and the largest scale of single point (factory) has reached 150,000 tons
- ❖ Great progress has been made in the treatment of three wastes (waste gas, waste water and waste residue): new processes and equipment for acid hydrolysis of exhaust gas; concentration and reuse of waste acid; recycle and comprehensive utilization of waste heat; comprehensive utilization of waste byproduct (recycling economy)

Problems and development bottlenecks:

- The production of titanium dioxide by sulfuric acid method leads to large amounts of “three wastes”, and the treatment and reuse are costly
- Overcapacity and low industry concentration and production scale are not conducive to waste treatment and environmental protection
- The pollutant discharge per unit of product is large, and the consumption of resources and energy is high
- The pollutant concentration of the waste water discharged by the industry is high, and the total pollutant discharge amount of the industry is large
- The proportion of heavily polluting capacity is far too high

Low-carbon green and cleaner production is the only road for China's titanium dioxide industry both currently and in the future.

Table 1 Processes and capacity of existing companies, companies under construction and companies under planning in China's titanium dioxide industry

	Item	Traditional method sulfuric acid method	Cogeneration method sulfuric acid method	Chlorination process	Total
Existing companies	Number of companies	58	4	1	63
	Total capacity (10,000 t)	110.5	36.5	3	150
	Output in 2009 (10,000 t)	73.43	29.92	1.65	105
Companies under construction	Number of companies	17	11	3	31
	Total capacity (10,000 t)	47.8	61	19	127.8
Companies under planning	Number of companies	5	14	3	22
	Total capacity (10,000 t)	14.5	105.5	40	160

Abstracted from: Li Xiaoliang, et al. Analysis of the Pollution Induced by Titanium Dioxide Industry in China and the Environmental Risk in the Future. China Population, Resources and Environment, 2011 (12) 393~397

Comparison of product resources, energy consumption and discharge of “three wastes” between three kinds of titanium dioxide manufacturing processes

	Item	Unit	Traditional sulfuric acid method	Cogeneration sulfuric acid method cleaner production process	Chlorination method
	Titanium concentrate (50% TiO ₂)	t	2.6	0-2.3	/
	Titanium slag (50% TiO ₂)	t	/	1.5-0	/
Resource consumption	High titanium slag (50% TiO ₂)	t	/	/	1.16
	Sulfuric acid (100%)	t	3.8	2.6-3.1	/
	Fresh water	t	100-150	60-75	35
Energy consumption	Equivalent standard coal	Kg	1600	≤900	1262
	Total	Nm ³	30000-35000	15000	870/1500
Waste gas	SO ₂	Kg	140	7.6	/
	Total	t	>100	<50	25
Waste water	COD	Kg	10.3	<2	1.25
Waste liquid	20% waste sulfuric acid	t	8	0	/
	Waste residue after acid hydrolysis	t	0.5	<0.25	/
Waste residue	Yellow plaster	t	3-8	2	/
	FeSO ₄ ·7H ₂ O	t	3	0	/
	Chlorinated waste residue	t	/	/	0.4

Abstracted from: Li Xiaoliang, et al. Analysis of the Pollution Induced by Titanium Dioxide Industry in China and the Environmental Risk in the Future. China Population, Resources and Environment, 2011 (12)

Table 3 Total amount of “three wastes” discharged by the titanium dioxide industry in 2009 and their respective proportions

Pollutant	Unit	Amount	Total amount in chemical industry	Proportion in the chemical industry
Waste water	10,000 t	9181	297061	3.09%
COD _{Cr}	10,000 t	1.25	42.7	2.93%
SO ₄ ²⁻	10,000 t	39.73		
Waste gas	100 million Nm ³	176.8	23174	0.77%
SO ₂	10,000 t	1.74	97.5	1.78%
Waste residue	10,000 t	230.59	1561 ¹	14.78%
Total amount of fresh water	10,000 t	10800	457788.4	2.36%
Consumption of fuel coal	10,000 t	157.5	8084.1	1.94%
Output value	100 million yuan	126	163557927.9	0.77%

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Iron oxide pigment manufacturing industry

- ❖ Iron oxide pigment is the second major inorganic pigment whose output is after that of titanium dioxide. Domestic output of iron oxide pigment in recent years is more than 600,000 tons, with sales income of over 3.7 billion yuan
- ❖ Domestic iron oxide pigment manufacturing industry keeps developing towards the direction of resource conservation, environmental friendliness and technological innovation
- Waste utilization: waste containing iron, acid leaching waste liquid from steel plants, byproduct of titanium dioxide production - ferrous sulfate, waste acid, and waste alkali.
- The traditional first-generation mainstream production technology is being upgraded to the second-generation technology (low-carbon green and cleaner production), and is developing towards the third-generation technology (integrated equipment, intelligentized control, low emission, and high-end product structure)
- ❖ **Problems:** energy consumption and pollution caused by the discharge of waste liquid

Lead and chromium pigment manufacturing industry

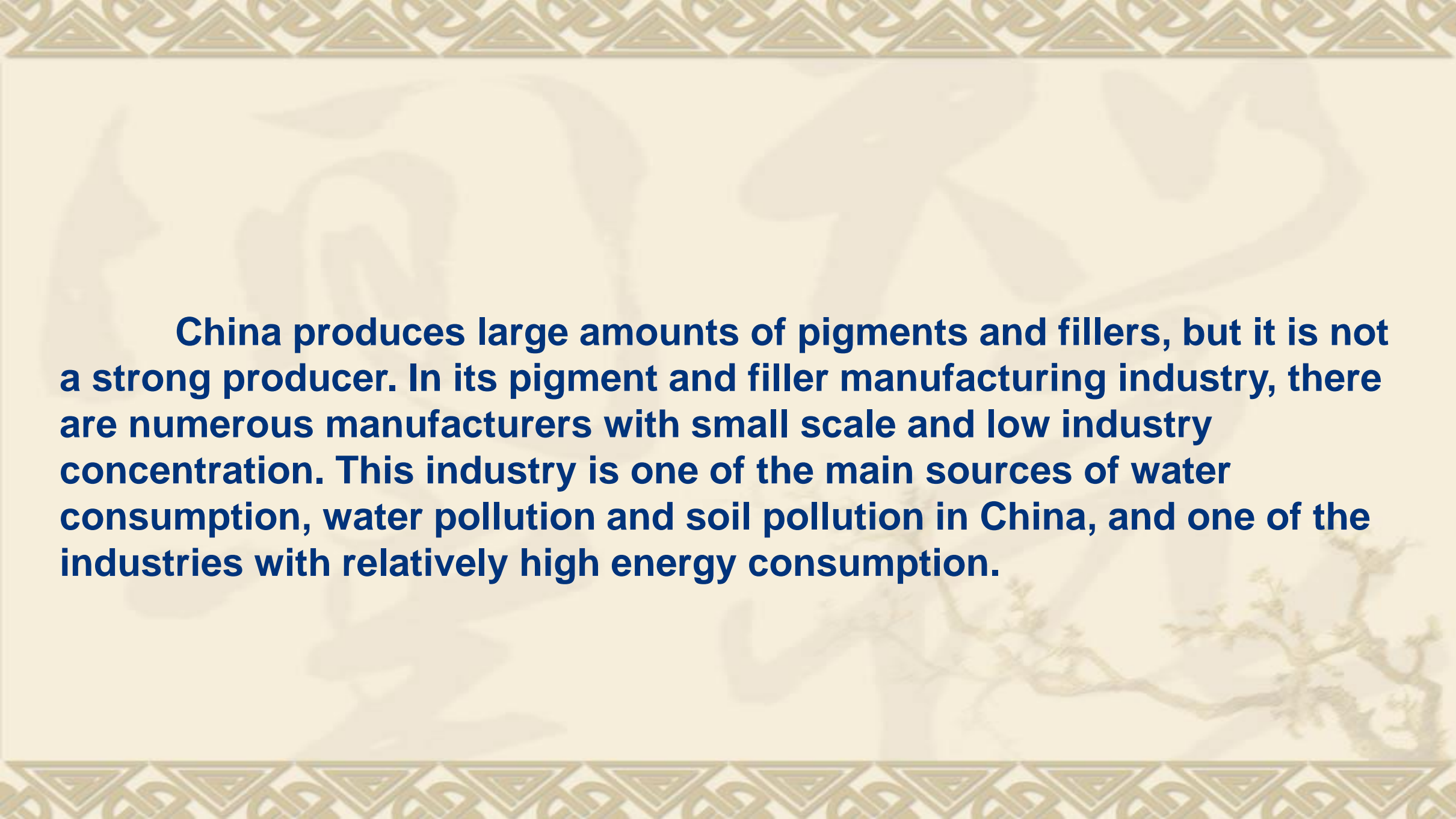
- ❖ Although the application of lead and chromium pigments in paint industry has been increasingly limited due to environmental safety and other factors, China's output and sales volume of lead chrome pigments in the last three years remains at about 60,000 tons
- ❖ Manufacturers are scattered with small production scale; many small and medium manufacturers have switched to other products or been shut down
- ❖ **Problems and challenges:**
 - The toxicity of lead and chromium pigments have increasingly limited their application scope
 - Environmental problems during the production process: pollution caused by the discharge of waste liquid and waste residue and treatment technologies

Organic pigment industry

- ❖ Major varieties used in the paint field: azo pigment, phthalocyanine pigment and high-performance pigments with other structures
- ❖ China is a major organic pigment producer. In the last three years, its output has remained at over 200,000 tons, 70% of which has been exported. The products are mainly middle- and low-end, of which the high-performance organic pigments are mainly exported
- ❖ **Major problems:**
 - Organic waste water, dust and waste gas are generated during the manufacturing process. Of them, organic waste water is most harmful and most difficult to treat. Organic waste water features high COD, high chroma, high salt content and low biodegradability, and often contains carcinogenic substances (such as aromatic amines and nitrites)
 - There are hundreds of organic pigment manufacturers in China. Most of them are small companies; their organic waste water cannot reach standard before discharge, so the environment is polluted somewhat; during the manufacturing process, labor protection is not in place, so the health of workers are greatly harmed

Production and processing of body fillers

- ❖ **Major varieties:**
calcium carbonate, talcum powder, kaolin, barium sulfate, mica powder, wollastonite, quartz powder, etc.
- ❖ **Current situation:**
 - **Manufacturers are scattered, with small scale and backward processes: disorderly exploitation, low resource utilization, difficult environmental protection and pollution abatement, and serious dust pollution**
 - **Deep processing and high value-added development and utilization are very weak**
- ❖ **Challenges:**
 - **Serious environmental problems exist during mining and processing: water consumption, wastewater pollution, dust pollution, etc.**



China produces large amounts of pigments and fillers, but it is not a strong producer. In its pigment and filler manufacturing industry, there are numerous manufacturers with small scale and low industry concentration. This industry is one of the main sources of water consumption, water pollution and soil pollution in China, and one of the industries with relatively high energy consumption.

Environmental protection is the common task of all mankind

- ❖ **Protection of surface water and water source**
 - Vegetation protection and soil and water conservation
 - Control of land desertification
 - Control of marine environment
- ❖ **Protection of atmospheric environment**
 - Control of ground-level ozone concentration
 - Control of atmospheric photochemical smog
 - Control of toxic organic solvent evaporation
- ❖ **Control and prevention of soil pollution**

The earth is the common homeland of all mankind

Coatings Care Program

Environmental regulations of various countries

Current environmental regulations of various countries:

❖ **The US – Rule-66**

CAA (Clean Air Act, 1970)

CAAA (Clean Air Act Amendments, 1990)

– HAPs (Hazardous Air Pollutants) List

Architectural and Industrial Maintenance (AIM) Coatings – VOC

❖ **Germany – AT-Luft Regulation (Clean Air Act, 1992) – VOC**

❖ **Japan – JMPAC put forward a report titled “VOC Status Quo and Future of Japan’s Paint Industry” – no regulations on the control of VOC yet**

❖ **China – Environmental Protection Law, 1979**

Standard for Discharge of Industrial “Three Wastes”, 1973

Standard for Atmospheric Environment Quality, 1982

❖ **International – ISO-14000, Environmental Management Standard**

❖ **European Union REACH regulations, RoHS**

China has attached great importance to environmental policies in recent years

- ❖ **Cleaner Production Promotion Law of the People's Republic of China (Version 2003) (2012 Amendment)**
- ❖ **Discharge Standard of Water Pollutants for Paint Manufacturing Industry (2nd exposure draft) – 2010**
- ❖ **Discharge Standard of Pollutants for Titanium Dioxide and Lithopone Industry (exposure draft) – 2011**
- ❖ **Discharge Standard of Pollutants for Inorganic Pigment Industry – Iron Oxides (under drafting)**
- ❖ **2009: Guidance on the Revitalizing and Supporting Technologies for the Petrochemical Industry**
- ❖ **December 2011: National “12th Five-Year Plan” for Environmental Protection was issued**
- ❖ **Ministry of Industry and Information Technology: Catalogue for Guiding Some Industrial Sectors to Eliminate Backward Production Technologies, Equipment and Products (Version 2010), Catalogue for Guiding Industry Restructuring (Version 2011) (Amendment)**

China has attached great importance to environmental policies in recent years

- ❖ **Ministry of Industry and Information Technology, Ministry of Science and Technology, Ministry of Environmental Protection: Catalogue of Substitutes to Toxic and Hazardous Raw Materials (Products) Encouraged by the State (Version 2012)**
- ❖ **Comprehensive Policy for Pollution Prevention and Control Technology for Fine Particulate Matter in Ambient Air (went into effect on September 25, 2013)**
- ❖ **Policy for Pollution Prevention and Control Technology for VOCs (went into effect on May 24, 2013)**
- ❖ **February 2013: Ministry of Environmental Protection issued “12th Five-Year Plan” for Prevention and Control of Environmental Risks for Chemicals**
- ❖ **September 2013: the State Council issued Action Plan for Atmospheric Pollution Prevention**

China has promulgated and implemented a series of mandatory national environmental standards and environmental labeling certification product standards for coating products

No.	Name of standard	Standard No.	Implementation date
1	Indoor decorating and refurbishing materials - limit of harmful substances of solvent coatings for woodenware	GB 18581-2009	June 1, 2010
2	Indoor decorating and refurbishing materials - limit of harmful substances of interior architectural coatings	GB 18582-2008	October 1, 2008
3	Limit of harmful substances of exterior wall coatings	GB 24408-2009	June 1, 2010
4	Limit of harmful substances of automobile coatings	GB 24409-2009	June 1, 2010
5	Indoor decorating and refurbishing materials - limit of harmful substances of water based woodenware coatings	GB 24410-2009	June 1, 2010
6	Limit of harmful substances of coatings for toys	GB 24613-2009	October 1, 2010
7	General specification for drinking water tank coating of shipbuilding	GB 5369-2008	December 1, 2009
8	The technical requirement for environmental labeling products - water based coatings	HJ/T 201-2005	January 1, 2006
9	Technical requirement for environmental labeling products - solvent-based wood coatings for indoor decoration and refurbishing	HJ/T 414-2007	April 1, 2008
10	Technical requirement for environmental labeling products - waterproof coatings	HJ 457-2009	May 1, 2009

Composition of paint-related industrial chain

1. Upstream raw materials industry:

❖ Pigments and fillers:

Inorganic pigments (titanium dioxide, iron oxides, lead and chromium, etc.)

Organic pigments (azo pigments, phthalocyanines, other high-performance pigments)

Fillers (calcium carbonate, talc powder, kaolin, barium sulfate, etc.)

❖ Resins: epoxy, polyester, alkyd, acrylic acid, chlorinated rubber, etc.

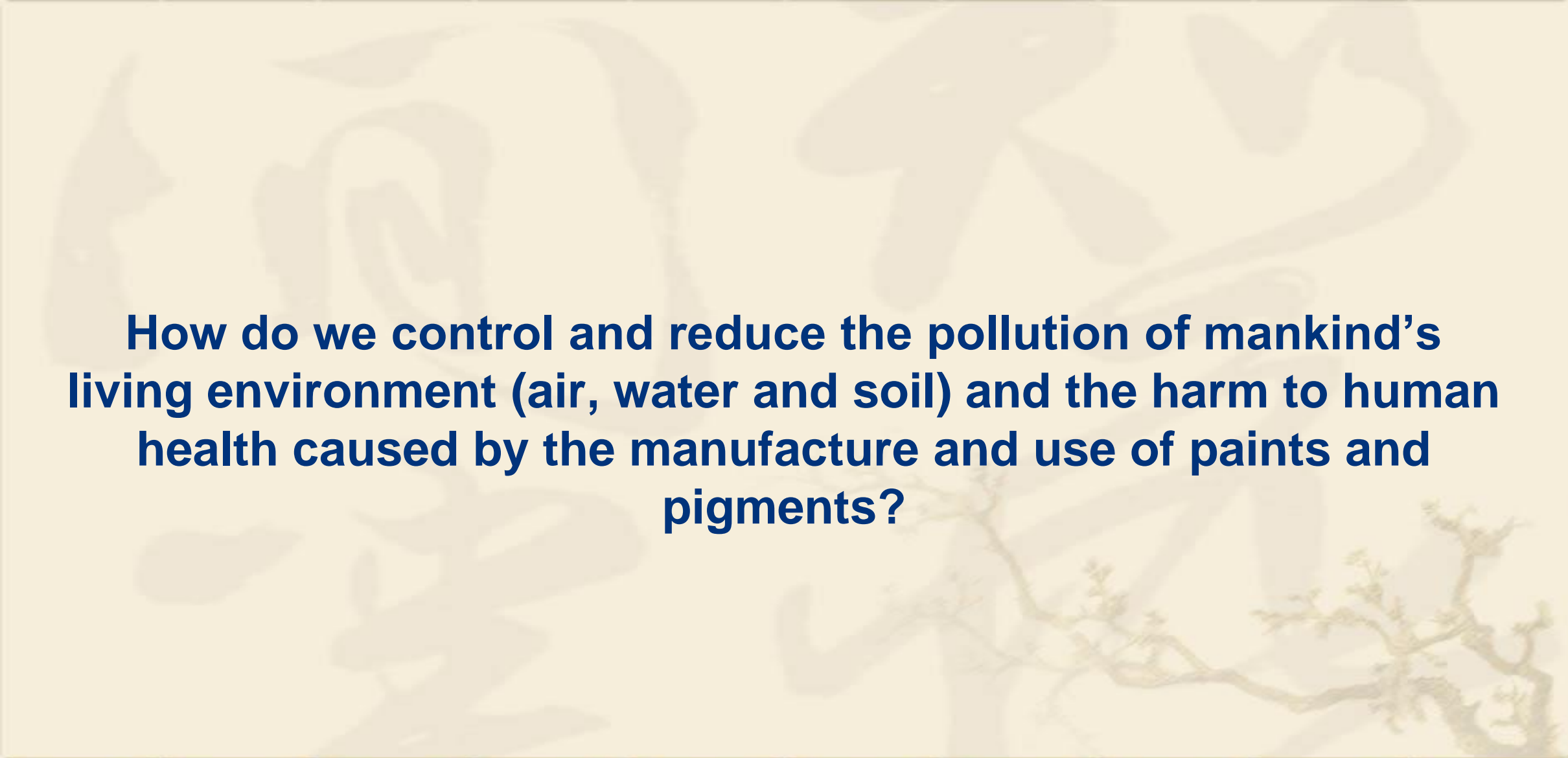

❖ Solvents, monomers

❖ Additives


2. Midstream resin and paint manufacturing industry

3. Downstream paint application: involving various industrial and economic fields

The whole industrial chain involves the pollution of surface water, soil and atmospheric environment and their prevention and control, and is one of the major industries which cause environmental pollution.



How do we control and reduce the pollution of mankind's living environment (air, water and soil) and the harm to human health caused by the manufacture and use of paints and pigments?



1. Accelerate the adjustment of product structure, develop environment-friendly paints

- ❖ **High-solid coatings**
- ❖ **Water-based coatings (including electrophoretic coatings)**
- ❖ **Powder coatings**
- ❖ **Radiation-cured coatings / solvent-free coatings**

2. Improve paint production and application processes and methods

- ❖ **Paint production process: traditional intermittent and open type → fully enclosed, integrated and continuous type**
- ❖ **Application processes and methods: manual workshop → industrialized and automated on-line application; controllable, enclosed, recyclable and reusable type (water curtain, combustion, absorption, adsorption filtration)**
- ❖ **Efficient and advanced application methods: electrophoresis, roller coating, UV (curtain coating), electrostatic spraying, etc.**


3. Improve paint life and cycle

Develop high-performance paints, increase paint life, and reduce paint consumption, thus decreasing environmental pollution, energy consumption and harm to human health caused by paint production and application

4. Develop and use environment-friendly alternative solvent products

Use low-toxicity and low-MIR solvents, such as DBE, dimethyl carbonate and SBAC

5. Further improve industry concentration, accelerate the elimination of backward production capacity, strengthen the constraint of energy conservation, environmental protection and other indicators, and curb the excessive growth of paint and pigment companies with high energy consumption and high emission

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- 6. Establish new industry standards of energy consumption and waste discharge for China's paint industry, and establish and improve clean and civilized production processes and energy conservation and emission reduction standards of paints and inorganic pigments**
- 7. Boost energy conservation and emission reduction via technological innovation and technological progress, and improve paint product quality, production equipment and processes and comprehensive utilization of resources via lifting technology; research and develop renewable raw materials and improve recycling technology to reduce the use of non-renewable resources**

Challenges and development bottlenecks facing China's paint industry

- ❖ Environmental pressure and product structure adjustment:
National environmental protection and industrial policies
Improvement of people's environmental awareness
- ❖ Pressure of increasing labor costs

Development bottleneck:

- ❖ Advanced environmental techniques
- ❖ Process technology and innovation

Cleaner production and low-carbon green is the only road for the sustainable development of China's paint industry. China's paint industry must transform from quantitative increase to qualitative increase.



**The future development direction of
China's main types of coatings**

Architectural coatings

- ❖ **Colorization:** color matching base paint, computer color matching system
- ❖ **Removing APEO from architectural emulsion / latex paint**
 - Ministry of Industry and Information Technology, etc. [2012] Document No.620: Catalogue of Substitutes to Toxic and Hazardous Raw Materials (Products) Encouraged by the State (Version 2012)
 - New standards: environmental labeling products - water-based coatings: **APEO is forbidden to be added**
- ❖ **Interior wall decoration DIY era:**
More environment-friendly non-VOC, odorless interior wall coating, **EVA latex paint**
- ❖ **Waterborneness of high-performance solvent-based exterior wall coatings:**
Water-based fluoro coatings, water-based metallic paints, water-based 2K-PU coatings, etc.
- ❖ **Waterborneness of coatings for the protection of construction steel:**
Water-based anti-corrosion primer, water-based fire retardant coatings, water-based top coat...
- ❖ **One of the future development trends of architectural decoration: molded decorative plate**
Prefabrication, finished product, standardization, industrialization; transforming from field operation to industrialized production and field installation
Develop coatings for interior and exterior decorative plates and adapt to assembly line application
- ❖ **Water-based and solvent-free floor coatings**

Water-based pigment paste and computer color matching system

- ❖ Water-based pigment paste (color paste) is a kind of stable pigment concentrate formed through dispersion after adding surfactant and/or disperser (resin) with water as the medium
- ❖ Color matching of architectural coatings / water-based coatings is usually realized by direct use of water-based pigment paste. Produced by specialized companies, the water-based pigment paste features good versatility and compatibility, and is easy to use, with no dust pollution
- ❖ With the popularity of water-based coatings, the application scope and amount of water-based color paste are growing
- ❖ Modern computer color matching system consists of: base paint, universal color paste, color card, integrated color matching software, color matching equipment
- ❖ Both satisfy the architectural coating retail market's needs for various colored paints as much as possible and reduce the complexity of the production process; both improve stores' flexibility of selling various colored paints in small quantities and avoid overstock

Suggestion: During the manufacturing and processing of pigments, pigment manufacturers may consider directly producing water-based pigment paste for the water-based coating market. By doing so, they can be free from post-heating and drying processes, thus saving energy and reducing waste water discharge.

Wood furniture and plastic coatings

- ❖ **Main future development direction: water-based coatings and UV coatings, but the latter is growing much faster than the former one**
- ❖ **Main types of water-based coatings: acrylic acid and polyurethane**
Acrylic emulsion: primer, ordinary top coat with general performance requirements
PUA: ordinary top coat with general performance requirements
PUD: wear-resistant flooring, soft plastic coatings
2K-PU: high-resistance top coat
- ❖ **UV coatings: color paint, waterborneness**

Automobile coatings

- ❖ **Automobile coatings: OEM paint and refinishing paint**
- ❖ **Automobile OEM coatings include: primer, intermediate coat, base paint and finishing paint, of which the base paint is divided into natural color paint and metallic paint**
- ❖ **Status quo of automobile coatings:**
Domestic car body application: primer is 100% water-based (cathodic electrophoretic paint), intermediate coat is being transformed to be water-based, and metallic paint has just been used (newly launched painting line)
- ❖ **Future:**
OEM paint gradually realizes the waterborneness of intermediate coat and metallic base paint
Refinishing paint and paint for other transportation vehicles (buses, trains and construction machinery): water-based epoxy anti-corrosion primer, water-based 2k-PU top coat

Industrial protective coatings

- ❖ Powder coatings:
- ❖ Water-based anti-corrosion coatings:
 - Electrodeposition coatings**
 - Water-based epoxy system:** self-drying epoxy ester and epoxy amidogen, 2k epoxy amine
 - Water-based acrylic system:** self-drying emulsion, amino acrylic acid
 - (Vinyl chloride - vinylidene chloride, chloroprene) emulsion system**
- ❖ Anti-corrosion coatings for shipping and marine engineering facilities
 - High-solid coatings:** acrylic polyurethane top coat, fluorocarbon top coat, silicone top coat; epoxy primer and intermediate coat; epoxy zinc-rich paint
 - Solvent-free coatings:** epoxy coatings, polyurethane coatings, polyurea coatings
 - Water-based coatings:** water-based inorganic zinc silicate; water-based epoxy paint water-based fluorocarbon top coat
 - Coatings with limited harmful elements:** chrome-free anti-rust pigment primer; top coats of non-lead chrome pigments, stannum-free self-polishing anti-fouling paint; low surface fluorosilicone anti-fouling paint; heat-resistant shop primer



Thank you!

