

**THE CATALYTIC PROCESS INDUSTRIES IN CHINA:
MARKETS, TECHNOLOGIES & STRATEGIC
IMPLICATIONS - UPDATE 2013**

- PRESENTATION -

**A Multi-Client Study Series
(completed April-June 2013)**



“The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications - Update 2013”

I. BACKGROUND

Launched as a study proposal in 2004, and then produced as four industry segment reports by The Catalyst Group Resources (TCGR) in April/May/June /July 2005, ***“The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications”*** was historic, insightful, and useful. The multi-client study was comprised of four (4) “stand alone,” but integrated reports on the Chinese market, each dedicated to a major catalytic process area: refining, petrochemical/chemical, polymerization and environmental (mobile and stationary) and provided analysis of the market size, growth factors, trade issues, pricing factors and R&D efforts of an increasingly important industry. Strategies and recommendations were provided in order for Western and other Asian companies to evaluate opportunities and begin participation.

Based on the 7-8 years that have passed, the catalytic process industries in China needed to be re-analyzed and segment reports updated in light of sector changes in technology, supply, security and political/regional influences. Due to the important changes which have occurred, TCGR, along with the China National Chemical Information Center (CNCIC), completed a four volume update, entitled ***“The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications - Update 2013.”*** This ***“Update 2013”*** delineates important changes to the landscape, the economics and the industry implications based on societal change and technology advances that have taken place over the past 7-8 years. This study has global strategic, commercial and technological uses and provides a serious guide for industry executives in business decision-making.

II. EXCERPTS FROM THE 2013 STUDY SERIES

Examples of findings in each of the four (4) segments of the 2013 report series include:

In refining catalysts:

- China’s refining industry is maturing and becoming more sophisticated from within and internationally. Key examples are highlighted – increased IOC domestic investment - the formation of the SINOPEC Catalyst Company now selling internationally - increasing numbers of international catalyst companies investing in China, e.g., Sud-Chemie/Clariant, Grace, BASF, Johnson Matthey, Umicore and others.
- The blazing increase in China’s thirst for energy to maintain its domestic growth has led to ever increasing international crude oil consumption and along with it the need to increase the complexity of its refining operations. This has resulted in increased hydrotreating, hydrocracking and octane processes as its international fuel standards propel higher to meet transport emission standards.

- The increasing deployment of R&D, at levels higher than in the OECD, with more numerous domestic and international patent awards.

More specifically, China has the ability to conduct independent research, development and production of refining catalysts according to the needs of the global refining industry. Properties of these catalysts have reached the world advanced level and some of them have been sold in overseas markets. In 2011 the capacity of oil refining catalysts in China reached 207.2 kt/a. Major oil refining catalyst varieties in China are catalytic cracking (FCC) catalysts and they account for 79% of the total capacity of oil refining catalysts. Hydrocracking, hydrotreating and catalytic reforming catalysts are also produced, per the Table below.

In 2011, the total output of oil refining catalysts in China was around 204.4 kt, imports were 8.9 kt, exports were around 25.0 kt, and apparent consumption was around 188.3 kt.

Capacity of the Oil Refining Catalyst Sector in China

Type	Capacity	% of Total	Output
FCC	193.0	93.15%	196.3
Reforming	1.3	0.63%	0.48
Hydrocracking & Hydrotreating	10.9	5.26%	6.05
Others	2.0	0.97%	1.6
Total	207.2	100.00%	204.4

In petrochemical/chemical catalysts:

- In 2011, China had over 170 specialized petrochemical catalyst manufacturers, 80 of which were manufacturers of syngas and its derivative catalysts, accounting for over 35% of petrochemical catalyst manufacturers; about 30 of which were oxidation catalyst manufacturers. Driven by the development of the Chinese chemical industry, China's catalyst industry will further develop. According to forecasts, China will consume 212.83 kt petrochemical catalysts in 2016, and will report 11.5% annual growth during 2011-2016. 2016 will not witness too many changes in consumption structure and will report higher percentage of consumption of catalysts for organic synthesis.
- Unlike the refining industry, which has been internationalizing driven by domestic energy demand and feedstock security impetus, China's petrochemical industry supply/demand is still largely domestically focused, albeit international chemical companies have invested in domestic production. It is more fragmented and less State run, bearing in mind the largest petrochemical producers SINOPEC, PetroChina and CNOOC are still integrated government companies.

- Technology and chemical catalysts outside of large commodity applications are still underdeveloped—based on scale, as well as lack of consolidation due to industry maturity—and are generally behind OECD standards in terms of cost/performance.

Key trends are shaping the next five years, with the stated petrochemical/chemical theme in China as “innovation and transformation, better industry layout, elimination of obsolete capacity and resource utilization.”

The study analyzes how the low percentage of China aromatics catalysts compared to the global consumption can be explained by the fact that most BTX catalysts and production processes use imported Western licensed technology, particularly for reforming and p-xylene production. Additionally, the doubling of catalyst consumption forecasted in this report between 2011 and 2016, attests to the opportunities contained within the Chinese petrochemical/chemical industry and the catalysts required to supply it.

The idea of transformation, along with innovation, in the petrochemical/chemical industry still has a long road ahead. The large number of Chinese catalyst manufacturers identified in this report will also need to consolidate, along with industry plans to do so within the chemical industry. These trends spell opportunity in growth for Western catalyst suppliers who produce domestically. For those seeking catalyst industry opportunities, this report shows that there are areas of more sophistication and areas where it is less so.

In polymerization catalysts:

Overall highlights:

- China is at an interesting junction in terms of its synthetic resins industry development cycle. In the last decade, it has focused on domestic self-sufficiency in resin production as well as in process technology and catalyst supply for commodity grades. Now it finds, not surprisingly, that during this same time, Western and other foreign product technology and more advanced value added catalyst technologies have not stood still. As a result, there is still a growing product need, particularly in more sophisticated segments like PE, where metallocene grades have expanded rapidly in the international market, spawning plastomers and other variants.
- The development trends in various polymerization catalyst products are critical to success. Traditional Z-N catalysts are now, and will remain, the main type of polymerization catalysts to be developed and produced, as they have a technical space for development. Metallocene catalysts are now being developed and will eventually be industrialized, as will late transition metal catalysts currently being investigated at the R&D level.

Polymer-specific highlights:

- There are currently seven polyolefin (PE and PP) catalyst producers in China. In 2011, China had a total polyolefin catalyst production capacity of 1940 t/a and a total output of 1189 tons, including a total PP catalyst capacity of 800 t/a and a total PP catalyst output of 553 tons. Capacity for PE catalysts reached 1140 t/a and output reached 636 tons. In 2011, China was able to supply more than 90% of its total polyolefin catalyst consumption
- Among elastomer catalysts in China, the relatively technically mature and industrially produced ones mainly include nickel-based catalysts for butadiene rubber, vanadium-based catalysts for EPR and neodymium-based catalysts for isoprene rubber. The two latter types of catalysts are being produced in China.
- China's PVC, PS and ABS polymerization initiators are relatively technically mature. Domestic initiator manufacturers' products can meet the needs of most resin manufacturers, but because the quality and stability of their initiator products are more secure, two major Western producers occupy a large share of China's initiator market.
- Most PET produced in China is PET chips. The catalysts used for the polymerization of PET chips are basically Sb (antimony)-based catalysts. $\text{Sb}_2(\text{OCH}_2\text{CH}_2\text{O})_3$ has better performance than Sb_2O_3 and $\text{Sb}(\text{Ac})_3$, and is considered to be the ultimate product of the antimony-based catalysts and will eventually replace Sb_2O_3 and $\text{Sb}(\text{Ac})_3$. In 2011, China's PET production was 27,100kt, which is calculated to consume about 8130t of antimony-based catalysts.

In environmental (mobile/stationary) catalysts:

Overall:

- In the face of increasing constraints from resources and the environment, China is being required to accelerate the upgrading of its technology, equipment and service level in energy conservation and environmental protection as defined in the Outline of the 12th Five-year Plan. It is estimated that the potential energy conservation via technological and economic changes will be more than 400 million tons of standard coal in 2015 and can bring about an investment of nearly RMB1000 billion. The total output value of energy conservation services may reach more than RMB300 and those for environmental services may reach RMB500 billion.
- Despite the rapid development in China's energy conservation and environmental protection sectors, their overall development level is still quite low. The major problems that participants in the emissions catalysts industries face are as follows: (1) the innovation ability is not strong; (2) the structure is not rational; (3) the market is not standardized; (4) the policy mechanism is not optimized; and (5) the service/support system is not complete.

Mobile Emission Catalysts:

- By the end of 2011, there were 27 enterprises in China producing ceramic-support tail gas catalysts for motor vehicles (automobiles and motorcycles), including 17 enterprises producing catalysts for motorcycles. In addition, there were four (4) enterprises specialized in the production of metal-support catalysts for motorcycles. It is expected that the output of motor vehicle three-way catalysts will reach 74.0ML in 2016 and the average annual growth will be 10.4% during 2011-2016. The demand for motor vehicle three-way catalysts will reach 78.0ML in 2016 and the average annual growth will be 11.6% during 2011-2016.

Stationary Catalysts:

- The total demand of SCR catalysts in thermal power plants of China will reach 83.2km³ in 2016. Of the total, the first-charge amount of catalysts in new generating units will be 42km³ (based on 50×106W new thermal power generating units), the additional amount of catalysts will be 31.3km³ and the renewal amount of catalysts will be 9.9km³.
- It is expected that with the constant increase of the sulfur capacity the output of Claus catalysts in China will reach 14.0kt in 2016 and the average annual growth will be 14.8% during 2011-2016. The demand of Claus catalysts in China will reach 10.0kt in 2016 (without considering the new sulfur capacity in 2016).

III. THE NEED FOR THIS STUDY “UPDATE”

Industrially, China continues its rapid transformation from a government regulated and managed system into a market-driven economy. These changes are occurring at the same time it is experiencing substantial fluctuation GDP growth! Such volatility adds enormous complexity into their indigenous catalytic process industries in refining, petrochemical/chemical, polymerization and environmental catalysis, all of which need to keep pace in technological evaluation and production capacity. Over the next decade, this spells “opportunity” for global as well as indigenous suppliers if they can understand and take advantage of the industrial dynamics in their respective industries.

Already, foreign investment capital in the range of \$100 billion is being deployed by the majors, including Shell, ExxonMobil, BP, BASF, Clariant/Süd-Chemie, Albemarle, W.R. Grace, etc. Concurrently, the demand and sophistication levels of the Chinese majors are also rapidly growing the industrial consumption of catalysts. While initial demand for new supply has traditionally been served via Western catalyst imports, increasingly they are being replaced by domestically produced product.

In no area of the globe is there greater potential for growth and opportunity than China. The PRC represents an enormous marketplace, yet it is characterized by complex industry structures and influential governmental participation. Understanding how the markets, the players and the local and national government bodies interact is crucial for successful

involvement. In addition, knowing the specific market sizes, potential for growth and opportunities for participation will undoubtedly increase the likelihood of success. The catalytic process industries, and the markets for catalysts themselves, represent large potentials, but also significant uncertainties. As a result, it is clear that both global and indigenous industry participants could benefit from an updated understanding, and assessment, of this situation.

IV. SCOPE & METHODOLOGY

As in its original study in 2004-05, the **“Update 2013”** was produced by the combined efforts of two well-known and well-respected sources: The Catalyst Group Resources (TCGR) and the China National Chemical Information Center (CNCIC), a Chinese government affiliated statistical bureau. These two organizations formalized their relationship via a Memorandum of Understanding (MOU) in September 2011 and this study demonstrates the strength and value of their combined efforts.

The TCGR/CNCIC “team” worked inside China and gathered locally (on the ground) information on the supply/demand, producers, the structure and changes (trends) expected over the next 5-10 years. Secondly, TCGR/CNCIC documents the supply chain by process. In addition to the statistical information, TCGR/CNCIC provides local and outside interpretation of the business in catalysts (as an industry) and how the end-users are driving change.

In this series of four (4) catalyst industry reports, the Chinese catalyst and catalytic process industries are broken into four major “segments” and documented with regard to the following topics:

- **Refining:** Fluid Catalytic Cracking; Reforming; Hydrocracking; Hydroprocessing; Other (including Isomerization, Lubes, etc.)
- **Petrochemical/Chemical:** Aromatic; Organic Synthesis; Oxidation; Syngas & Derivatives; Hydrogenation & Dehydrogenation
- **Polymerization:** Polyethylene; Polypropylene; Elastomers; PVC; PS; ABS; PET
- **Environmental:** Mobile; Stationary

Each of the four segment reports is a “stand alone” but integrated strategic assessment of the current situation in China. It offers executive level guidance on opportunities and threats, with supporting data to enable further analyses in-house. Reports document markets sizes, suppliers and buyers, industry structure, price trends and trade flows as well as technological developments and the competitive landscape. Analyses are provided so that resultant opportunities are identified and characterized, including notable hurdles.

Conclusions and recommendations are made with specific action steps to be considered for short-term implementation.

In this approach, TCGR combines its understanding of the global catalyst industries, including the markets, technologies, participants and strategic issues, along with the detailed and local knowledge of the China National Chemical Information Center (CNCIC), in order to provide insightful analyses and assessments of the major segments. TCGR incorporates data assembled by CNCIC, collected via internal PRC sources as well as primary market research surveys, and assesses the findings as to their importance to, and impacts on, global companies seeking to participate in PRC's strong prospects for the future. The insights provide guidance and recommendations to help steer involvement and evaluate options.

The locally-collected market data by CNCIC, along with the technological assessments and competitive/strategic implications by TCGR, allows subscribers to derive strategies and begin or enhance their participation.

Included in the areas being assessed, by catalytic process, are:

- Industry Overview
- Current Status
- Segment Analysis (by Sub-segment)
 - Introduction
 - Manufacturers and Output
 - Consumers and Consumption
 - Trade (Imports and Exports)
 - Prices and Affecting Factors
 - Market Drivers
 - Technology Development
 - Forecast of Market Trends
- Issues/Concerns
- Opportunities/Challenges
- Conclusions

Particular attention is given to how the industry segment operates within China as well as how, and to what degree, it interacts with global companies (customers, suppliers, etc.). There are also highlighted differences between methods and operations of Chinese companies relative to Western and/or other Asian participants.

In developing its assessment, TCGR/CNCIC also notes indigenous R&D and process technology directions that differ from their Western counterparts. These analyses are insightful for those contemplating future investment in PRC.

The actual Table of Contents for each of the four (4) segment reports is presented at the end of this presentation (see pp. 11-34).

In order to heighten the value-added from study participation, TCGR/CNCIC worked with “charter” subscribers (i.e., those who signed up for the study by November 14th, 2012) to define the scope of the report by delineating areas of particular interest for inclusion in each assessment.

V. QUALIFICATIONS

The Catalyst Group Resources (TCGR) and the China National Chemical Information Center (CNCIC) are uniquely qualified to provide this catalyst industry report series. TCGR is the leading global catalyst industry consulting organization with nearly 30 years of experience serving a global client base. Among its most prominent reports, produced bi-annually since 1986, is *The Intelligence Report: Business Shifts in the Global Catalytic Process Industries*, which addresses the global catalyst and process technology industries. An “industry standard” for almost 30 years, each edition provides a comprehensive, global assessment of the refining, petrochemical, polymer, fine/pharma, and environmental catalyst industries.

The China National Chemical Information Center (CNCIC) is China’s leading data and information provider, with proven capabilities in data gathering and industry evaluation. CNCIC is conducting the local data collection in China, through sources in the PRC as well as through primary market research interviews. It is also providing insightful analyses and commentary on issues and opportunities affecting market participation, from both indigenous Chinese and external (Western, other Asian) perspectives. CNCIC has unique capabilities and contacts within the local market to permit detailed data collection as well as to provide industry insights.

Together, the “team” of these two organizations provides complimentary capabilities in a unique industry service available through this multi-subscriber report series from TCGR/CNIC.

VI. DELIVERABLES & PRICING

This report series is timely and strategically important to catalyst producers and others involved in the global catalytic process industries. Based on CNCIC’s locally-conducted (in PRC) interviews and data sources, as well as TCGR’s proven industry experience and perspective, each segment report in the series provides subscribers unparalleled insights into an increasingly important area.

Each segment report is a “stand alone” document of 75-100 pages with all pertinent insights into the industry, the opportunities and the risks, including segment-specific recommendations. Reports follow a prototypical outline and can be purchased individually or as a group (of 2, 3 or all 4 reports).

Report Segment

- I. Refining Catalysts in PRC – Update 2013
- II. Petrochemical/Chemical Catalysts in PRC – Update 2013
- III. Polymerization Catalysts in PRC – Update 2013
- IV. Environmental Catalysts in PRC – Update 2013

Availability

- April 2013
- May 2013
- May 2013
- June 2013

Participation

- Each (1) Catalyst Segment in PRC Report
- Any two (2) Catalyst Segment Reports
- Any three (3) Catalyst Segment Reports
- All four (4) Catalyst Segment Reports

Price

- US\$11,500
- US\$18,500
- US\$24,500
- US\$29,500
- US\$1,000

Each report segment in PDF format
(in addition to subscription price)

The segment reports became available on a rolling basis in the second quarter of 2013. The Refining Catalysts report was ready in April 2013, the Petrochemicals/Chemicals report in May 2013, the Polymerization report in May 2013, and the Environmental report in June 2013.

- Notice to Subscribers of the 2005 Multi-Client Study Series -

Due to the complementary nature of this study series to the one completed back in 2005, we are offering a discounted price to subscribers of that series. Subscribers are requested to contact TCGR's John J. Murphy at +1.215.628.4447, or John.J.Murphy@catalystgrp.com for further details. When completing the order form, please make sure to indicate your company's subscription to the 2005 multi-client series.

The study series, ***"The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications – Update 2013,"*** is available on a subscription basis from The Catalyst Group Resources (TCGR) and the China National Chemical Information Center (CNCIC).

Mr. John J. Murphy
john.j.murphy@catalystgrp.com
 +1.215.628.4447
The Catalyst Group Resources
 P.O. Box 680
 Spring House, PA 19477 - USA -
www.catalystgrp.com

Mr. Arley Li
liyonglei@cncic.gov.cn
 +86.10.6443.2152
China National Chemical Information Center
 No. 53 Xiaoguan Street, Huaxin Mansion
 Chaoyang District, Beijing 100029 – CHINA –
www.cncic.gov.cn/en/

ORDER FORM AND SECRECY AGREEMENT

The Catalyst Group Resources, Inc.
 Gwynedd Office Park
 P.O. Box 680
 Spring House, PA 19477 -USA-

Tel: +1-215-628-4447
 Fax: +1-215-628-2267
 e-mail: tcgr@catalystgrp.com
 website: www.catalystgrp.com

_____ Please enter our order for your report series entitled ***“The Catalytic Process Industries in China - Markets, Technologies & Strategic Implications – Update 2013,”*** completed in Q2, 2013. The cost of one of the “segment reports” is US\$11,500; two segments are US\$18,500; three segments are US\$24,500 and all four segment reports are US\$29,500. The segment reports we are ordering are:

<u>Segment Report Title</u>	<u>Selected (mark w/ “X”)</u>	<u>Expected Completion</u>
Refining Catalysts in PRC	_____	April 2013
Petrochemical/Chemical Catalysts in PRC	_____	May 2013
Polymerization Catalysts in PRC	_____	May 2013
Environmental Catalysts in PRC	_____	June 2013

_____ Please enter our order for each segment report to be delivered in PDF (Adobe Acrobat) format for use across our sites/locations for an additional \$US1,000 (each segment).

_____ * * * We are subscribers to the 2005 multi-client series ***“The Catalytic Process Industries in China - Markets, Technologies & Strategic Implications”*** and are therefore entitled to the discounted subscription rate. * * *

In signing this order form our company agrees to hold this report(s) confidential and not make them available to subsidiaries unless a controlling interest (>50%) exists.

Signature: _____ Date: _____

Name: _____ Title: _____

Company: _____

Billing Address: _____

Shipping Address (no P.O. Boxes): _____

Express delivery services will not deliver to P.O. Boxes

City: _____ State/Country: _____

Zip/Postal Code: _____ Phone: _____

E-mail: _____ Fax: _____

This report and the study findings are sold for the exclusive use of the client companies and their employees only. No other use, duplication, or publication of this report or any part contained herein is permitted without the expressed written consent of The Catalyst Group Resources.

REFINING CATALYSTS

TABLE OF CONTENTS

SECTION I. INTRODUCTION.....	1
SECTION II. EXECUTIVE SUMMARY	3
A. The Energy Environment in China	5
1. Primary Energy Resources	5
2. Oil Supply/Demand.....	6
B. Alternative Fuels and Routes to Chemicals.....	7
1. Coal-to-Dimethyl Ether (DME)	7
2. Coal-to-liquids (CTL).....	8
C. The International Refining Catalyst Market and PRC’s Role Within It.....	10
D. Oil Refining Catalysts in China.....	13
SECTION III. THE OIL REFINING CATALYST INDUSTRY IN CHINA	17
A. Summary.....	17
1. Introduction to the Oil Refining Industry in China	17
2. Brief Introduction of Oil Refining Catalysts in China	24
B. Industrial Structure	25
1. Producers	26
a. SINOPEC Corp. Changling Company.....	27
b. SINOPEC Corp. Qilu Company	28
c. SINOPEC Corp. Fushun Company.....	28
d. SINOPEC Catalyst Company Nanjing Division.....	28
e. Hunan Jianchang Petrochemical Co., Ltd.....	29
f. PetroChina Lanzhou Company - catalysts plant	29
g. PetroChina Fushun (North) Company - catalysts plant	29
h. XinNian Petrochemical Additives Company	30
i. Shenyang Sanju Kaite Catalyst Co., Ltd.....	30
j. Shanxi Tengmao Technology Co., Ltd	30
k. LeShan ReZel Catalysts Co., Ltd.....	31
l. Ingdao Huicheng Petroleum Chemical Technology Co., Ltd.....	31
m. Noblestar Catalysts Co., Ltd	31
2. Research Institutes.....	33

C. ANALYSIS OF THE MARKET SUPPLY/DEMAND BALANCE	34
1. Production of Oil Refining Catalysts in China.....	34
a. FCC	34
b. Catalytic reforming	34
c. Hydrocracking and hydrofining	34
d. Other catalysts.....	34
2. Consumption of Oil Refining Catalysts in China.....	37
a. Catalytic cracking catalysts.....	37
b. Reforming catalysts.....	37
c. Hydrogenation catalysts	38
3. Imports and Exports	39
a. The profile of import of petroleum refining catalysts	39
b. The profile of export of petroleum refining catalysts	40
4. Analysis of the Market Supply/Demand Balance of Oil Refining Catalysts	42
D. PRICE CHANGES AND AFFECTING FACTORS	44
1. Price Changes of Refining Catalysts	44
2. Factors Affecting Price Changes	45
E. MARKET GROWTH AND AFFECTING FACTORS	46
1. Market Growth	46
2. Affecting Factors	47
a. Economic growth drives petroleum demand strongly	47
b. Clean fuel promotes the rising demand of catalyst	48
F. TECHNOLOGIES OF OIL REFINING CATALYSTS	50
1. Relatively Mature Technologies.....	50
a. Catalytic cracking (FCC) catalysts.....	50
b. Hydrogenation catalysts	51
i. RN series of hydrofining catalyst.....	51
ii. Hydrofining RS series of catalyst.....	51
iii. Medium-pressure hydro-modification catalyst RT-5	52
iv. 3974 catalyst.....	52
v. Catalysts of residual oil hydrogenation RHT	53

vi.	Hydrocracking catalysts FC-14 which can produce a large amount of diesel	53
vii.	Hydrocracking pretreatment catalyst	54
viii.	Paraffins hydrofining catalysts.....	54
ix.	RMC-II medium pressure hydrocracking catalysts.....	55
c.	Catalytic reforming catalysts	56
i.	Pt - Re/Al ₂ O ₃ half regeneration reforming catalyst.....	56
ii.	Pt-Sn/Al ₂ O ₃ continuous reforming catalyst.....	56
2.	Relatively New Technologies	57
a.	Heavy oil catalytic cracking processes and catalysts.....	58
b.	FCC gasoline, diesel hydrotreating	58
i.	Petroleum selective hydrogenation	58
ii.	Catalysts and additives for gasoline with reduced olefin content	59
iii.	Gasoline hydrodesulfurization catalyst	59
iv.	Gasoline binary hydrogenation catalyst LY-9802	59
c.	Hydrocracking PHC-03 catalyst	60
G.	Spent Catalyst Recycling	60

SECTION IV. ISSUES AND CONCERNS IN THE CHINESE ENERGY AND REFINING CATALYST INDUSTRY 61

A.	The Energy Industry	61
1.	Less Petroleum Reserves, Higher Dependence on Imported Petroleum.....	61
2.	High Consumption of Coal, Serious Environmental Pollution	61
3.	New Energy Resources Abundant, but Underutilized.....	61
B.	Rapidly Evolving Laws and Regulations	63
1.	The 12 th of 5 Years Plan of Petrification Chemical Industry	63
2.	The Policy of Coal Chemicals.....	63
C.	The Catalyst Industry.....	65
1.	More Varieties but Less Serialization	66
2.	Long Period from the Development to Industrialization of New Products....	67
3.	No Breakthrough for the New Generation of Molecular Sieve Cracking Active Components	67
4.	Fierce Competition Between the Catalysts Companies, and the Technologies are Secret from Each Other.....	67

SECTION V. OPPORTUNITIES AND THREATS TO THE CURRENT SITUATION IN THE CHINESE REFINING CATALYST INDUSTRY 69

A. Limited Restriction to Foreign Participation	69
B. Changing Energy and Fuel Requirements	69
C. Future R&D Needs	72
1. Heavy Oil Cracking Catalyst.....	72
2. Gasoline, Diesel Quality, Reduced Environmental Pollution Catalyst	72
a. FCC gasoline with reduced olefin content	72
b. Etherification technology of catalytic cracking light gasoline.....	72
c. FCC gasoline desulfurization	72
3. Reforming Catalysts	73
D. Alternative Fuels and Related Catalyst Needs.....	73
1. The Catalysts of Coal Conversion Into Petroleum.....	73
a. Coal direct liquefaction	73
b. Indirect coal liquefaction.....	73
2. The Catalyst of Methyl Alcohol Synthesized from Syngas	74
3. The Catalyst of Methyl Alcohol Conversion to Dimethyl Ether (DME).....	75

SECTION VI. CONCLUSIONS AND RECOMMENDATIONS 77

A. Conclusions from an International Perspective	78
B. Recommendations from an International Perspective	79

FIGURES

Figure II-1	Composition of the Capacity of Oil Refining Catalysts in 2011	13
Figure II-2	Composition of the Output of Oil Refining Catalysts in 2011	14
Figure II-3	Market Shares Held by Major Oil Refining Catalyst Producers in China.....	15
Figure II-4	Consumption Composition of Oil Refining Catalysts in China in 2011	15
Figure III-1	Administrative Affiliation of Oil Refining Catalyst Producers and Research Institutes in China	26
Figure III-2	Oil Refining Catalyst Capacity in 2011	35
Figure III-3	Oil Refining Catalyst Output in 2011	36

Figure III-4	Market Share of China's Major Oil Refining Catalyst Producers.....	37
Figure III-5	Oil Refining Catalysts Consumption, by Segment, in China in 2011	38
Figure III-6	Demand Changes for Crude Oil in China.....	47

TABLES

Table II-1	China's Major Proven Reserves of Primary Energy	5
Table II-2	Oil Supply and Demand in China, 2006-2011.....	6
Table II-3	Production Situation of Dimethyl Ether (DME) in China in 2002-2011 and the Prediction in 2016	8
Table II-4	Main Production Enterprises of Coal to Liquid in China in 2011	9
Table II-5	Production Situation of Coal to Liquid in China in 2006-2011 and the Prediction in 2016	9
Table II-6	Changes in Worldwide Refining Capacity 2011 vs. 2010 (World).....	10
Table II-7	Regional Look at Worldwide Refining Operations 2011	11
Table II-8	Global Refinery Catalyst Market: 2009-2017	12
Table II-9	Production of Oil Refining Catalysts in China	13
Table II-10	Production of Major Oil Refining Catalyst Producers in China.....	14
Table III-1	Number of Refineries in China and Their Capacity Distribution.....	18
Table III-2	Capacity of Major Crude Oil Processing Enterprises in China	18
Table III-3	Composition of The Major Process Units in Oil Refining Enterprises in China 2011	21
Table III-4	Capacity of the Oil Refining Catalyst Sector in China.....	24
Table III-5	Major Oil Refining Catalyst Varieties in China	24
Table III-6	Major Oil Refining Catalyst Producers in China.....	27
Table III-7	Major Oil Refining Catalyst Producers in China and their Contact Details	32
Table III-8	Research Institutes Engaged in Oil Refining Catalyst Research in China.....	33
Table III-9	Production of Oil Refining Catalysts in China	35
Table III-10	Production of Major Oil Refining Catalyst Producers in China.....	36
Table III-11	Consumption Composition of Oil Refining Catalysts in China in 2011	39
Table III-12	Imports and Exports of Oil Refining Catalysts in China in 2011	39

Table III-13	Analysis of the Market Supply/Demand Balance of Oil Refining Catalysts in China	43
Table III-14	Catalyst Efficiency in Refining Industry in China.....	44
Table III-15	Price Changes of Oil Refining Catalysts in China.....	44
Table III-16	Demand Projection for Oil Refining Catalysts in China	47
Table III-17	Comparison of Gasoline Specifications between China and Europe ..	48
Table III-18	Comparison of Diesel Specifications between China and Europe	48
Table III-19	Timetable for Diesel and Gasoline Quality Upgrading in China.....	49
Table III-20	Physical and Chemical Properties of RN-10 Catalyst	51
Table III-21	Physical and Chemical Properties of RS Pre-hydrogenation Catalyst	52
Table III-22	Composition of Semi-Regeneration Reforming Catalysts.....	56
Table III-23	Physical and Chemical Properties of Continuous Reforming Catalysts.....	57
Table V-1	Capacity Expansion of Oil Refining Catalysts in China.....	71

PETROCHEMICAL/CHEMICAL CATALYSTS

TABLE OF CONTENTS

SECTION I. INTRODUCTION.....	1
SECTION II. EXECUTIVE SUMMARY	3
SECTION III. THE PETROCHEMICAL/CHEMICAL CATALYST INDUSTRY IN CHINA.....	11
A. Petrochemical industry overview	11
B. Overview of petrochemical catalyst industry in China.....	12
1. Brief introduction to petrochemical catalyst industry in China	12
2. Petrochemical catalyst manufacturers in China	15
3. Petrochemical catalyst science and research organizations in China.....	18
C. Analysis of production and consumption balance of petrochemical catalysts in China.....	21
1. Overview	21
2. Analysis of petrochemical catalyst production in China.....	21
a. Petrochemical catalyst manufacturers in China	21
i. Aromatic compound catalyst	21
ii. Organic synthesis catalyst.....	22
iii. Oxidation catalyst	23
iv. Syngas and its derivative catalyst	24
v. Hydrogenation and dehydrogenation catalyst	27
vi. Others.....	30
b. Petrochemical catalyst output in China.....	31
3. Analysis and forecast of petrochemical catalyst consumption in China	33
a. Aromatic compound catalyst	33
i. BTX	33
ii. Alkylation of ethylene and benzene into ethylbenzene	33
iii. Alkylation of propylene and benzene into cumene	34
b. Organic synthesis catalyst.....	34
i. Catalysts for the oxo-synthesis of butanol and octanol	34
ii. Preparation of acetic acid by oxo synthesis	35
iii. Synthesis of vinyl chloride from calcium carbide and acetylene	35

c.	Oxidation catalyst.....	36
i.	Organic chemical	36
ii.	Inorganic chemicals	42
d.	Syngas and derivative catalyst	43
i.	Syngas in synthetic ammonia production—CO+H ₂	43
ii.	Carbon monoxide shift catalysts.....	43
iii.	Methanation	44
iv.	Ammonia synthesis.....	44
v.	Hydrogen production	45
vi.	Preparation of chemicals from syngas	45
vii.	Methanol.....	46
viii.	Methanol to olefin.....	46
ix.	Coal to ethylene glycol	48
e.	Hydrogenation catalyst.....	48
i.	Purification of feed gas for synthetic ammonia	48
ii.	Olefin (ethylene, propylene) purification	49
iii.	Refining terephthalic acid.....	49
iv.	Butyraldehyde and octenal hydrogenation to 2-ethyl hexanol	50
v.	Hydrogenation of benzene to cyclohexane and the hydrogenation of benzene to caprolactam.....	50
vi.	Hydrogenation of nitrobenzene to aniline	51
vii.	Grease hydrogenation	51
viii.	Others.....	52
f.	Dehydrogenation catalyst.....	52
i.	Dehydrogenation of ethylbenzene to styrene.....	52
ii.	The dehydrogenation of isopropanol to acetone.....	53
iii.	Dehydrogenation of cyclohexanol to cyclohexanone (caprolactam).....	53
iv.	Preparation of butadiene from butene.....	53
v.	Preparation of isobutene from isobutane	54
g.	Others	55
h.	Summary	55
4.	Import and export	59
5.	Analysis of supply and demand balance of petrochemical catalysts.....	59

6.	Price movements and influencing factors	62
D.	Current technologies and R&D progress of major petrochemical catalysts.....	62
1.	Aromatic compound catalyst.....	62
a.	BTX isomerization catalyst.....	62
b.	Toluene disproportionation and transalkylation catalyst	63
c.	Synthesis of ethylene and benzene to ethylbenzene	65
d.	Alkylation of propylene and benzene into cumene.....	67
2.	Organic synthesis catalyst	68
a.	Oxo-synthesis of propylene to butanol and 2-ethyl hexanol.....	68
b.	Oxo synthesis of methanol to acetic acid.....	69
3.	Oxidation catalyst.....	69
a.	Partial oxidation of ethylene to ethylene oxide.....	69
b.	Epoxypropane (hydrogen peroxidation process)	70
c.	Production of VAM through ethylene and acetylene.....	70
d.	Oxidation of propylene to acrylate.....	71
e.	Ammoxidation of propylene to acrylonitrile	72
f.	Oxidation of n-butane or benzene to maleic anhydride	73
g.	Isobutene (tertiary butanol) oxidation to MMA.....	74
h.	O-xylene oxidation to phthalic anhydride.....	75
i.	PX oxidation to terephthalic acid.....	75
j.	Methanol oxidation to formaldehyde.....	76
4.	Syngas and derivative catalyst	76
a.	Synthesis of methanol from carbon monoxide and hydrogen.....	76
b.	Direct synthesis of syngas to dimethyl ether	77
c.	Production of light olefins directly from synthesis gas (syngas-to-olefins)	78
d.	Production of aromatics from syngas (syngas-to- aromatics).....	78
e.	Production of ethanol from syngas (syngas-to-ethanol)	78
f.	Production of olefin from methanol.....	79
g.	Conversion of methanol into aromatics (methanol-to-aromatics)	81
h.	Alkylation of toluene and methanol into p-xylene.....	82
i.	Coal to ethylene glycol	82

5. Hydrogenation catalyst.....	83
a. Olefin purification.....	83
i. C ₂ selective hydrogenation	83
ii. Purification in propylene hydrogenation	84
b. The hydrogenation of benzene to cyclohexane.....	84
c. PTA	85
6. Dehydrogenation catalyst.....	86
a. Dehydrogenation of ethylbenzene to styrene.....	86
b. Dehydrogenation of isopropanol to acetone	88
c. Isobutene	88
i. Dehydrogenation of iso-butane to isobutene	88
ii. MTBE cracking process.....	89
7. Others	89

**SECTION IV. ISSUES AND CONCERNS IN THE CHINESE
PETROCHEMICAL/CHEMICAL CATALYST INDUSTRY..... 91**

A. Issues.....	92
1. Chinese catalytic process industries are comprehensive.....	92
2. R&D remains insufficient, inefficient	92
3. Strength of leaders hindering progress	92
B. Concerns	92
1. Catalyst processes which are “green” are needed	93
a. MMA production	93
b. Epoxypropane production	93
2. New raw material substitution routes should be pursued.....	94
a. Alkane conversion process.....	94
b. New coal-based chemicals production process.....	95
3. Development and applications of new catalytic materials are justified	96
a. Cellular compound material.....	97
b. Amorphous alloys	97
c. Nano materials	97
d. Ionic liquids.....	97

SECTION V. OPPORTUNITIES AND THREATS TO THE CURRENT SITUATION IN THE CHINESE PETROCHEMICAL/CHEMICAL CATALYST INDUSTRY.....	99
SECTION VI. CONCLUSIONS AND RECOMMENDATIONS	101
SECTION VII. APPENDIX.....	103

FIGURES

Figure II-1 Consumption of Petrochemical/Chemical Catalysts in China in 2011	7
Figure III-1 Consumption of Petrochemical/Chemical Catalysts in China in 2011 (% of total)	56

TABLES

Table II-1 Output of Petrochemical and Chemical Catalysts in China in 2011	5
Table II-2 Global Petrochemical/Catalyst Market by Application	8
Table III-1 Supply and Demand of Major Petrochemical Products in China in 2011	12
Table III-2 Global Petrochemical/Catalyst Market by Application	14
Table III-3 A Selection of the Major Petrochemical Catalyst Producers in China	15
Table III-4 Major Petrochemical and Chemical Catalyst Research Institutes in China	18
Table III-5 Contact Details for the Major Petrochemical and Chemical Catalyst Research Institutes in China.....	20
Table III-6 Production of Aromatic Compound Catalysts in China.....	21
Table III-7 Production of Major Organic Synthesis Catalysts in China.....	22
Table III-8 Production of Major Oxidation Catalysts in China.....	23
Table III-9 Production of Major Syngas and its Derivative Catalysts in China.....	25
Table III-10 Production of Major Hydrogenation and Dehydrogenation Catalysts in China.....	27
Table III-11 Output of Petrochemical and Chemical Catalysts in China in 2011	31
Table III-12 Consumption of Petrochemical and Chemical Catalysts in China in 2011 and Forecast	57
Table III-13 Import and Export of Petrochemical and Chemical Catalysts in China in 2011	59
Table III-14 Supply/Demand Balance of Petrochemical and Chemical Catalysts in China in 2011	60

Table III-15	Operating Results of SKI Series Catalysts of SINOPEC Shanghai Research Institute of Petrochemical Technology	62
Table III-16	Operating Conditions and Technological Indicators of HAT Series Toluene Disproportionation Catalysts of SINOPEC Shanghai Research Institute of Petrochemical Technology	64
Table III-17	Major Physical and Chemical Properties of AB Series Ethylbenzene Catalysts of SINOPEC Shanghai Research Institute of Petrochemical Technology	65
Table III-18	Reaction Performance of AB Series Ethylbenzene Catalysts of SINOPEC Shanghai Research Institute of Petrochemical Technology	66
Table III-19	Major Technology Indicators and Attributes of MEB-01 Catalyst of SINOPEC Shanghai Research Institute of Petrochemical Technology	66
Table III-20	Major Technological Indicators and Attributes of MP-01 Catalyst of SINOPEC Shanghai Research Institute of Petrochemical Technology	68
Table III-21	Comparison results of CTV-III, CTV-IV and CTV-V Catalysts of SINOPEC Shanghai Research Institute of Petrochemical Technology	71
Table III-22	Operating Conditions Suitable for Acrylonitrile Catalyst of SINOPEC Shanghai Research Institute of Petrochemical Technology	72
Table III-23	Overview of Some Benzene to Maleic Anhydride Catalysts in China	74
Table III-24	Operating Conditions Suitable for C312 Series Catalysts of Southwest Research and Design Institute of Chemical Industry	77
Table III-25	Major Indicators of CTP-II and CTP-III Catalysts of SINOPEC Shanghai Research Institute of Petrochemical Technology	85
Table III-26	Physical Property Indicators of GS Series Catalyst of SINOPEC Shanghai Research Institute of Petrochemical Technology	87
Table III-27	Reaction Performance of GS Series Catalyst of SINOPEC Shanghai Research Institute of Petrochemical Technology	87
Table III-28	Attributes of GS Series Catalyst of SINOPEC Shanghai Research Institute of Petrochemical Technology	88
Table III-29	Conditions for Hydration -Dehydrogenation of Propylene to Acetone Process	88
Table VII-1	Major Petrochemical Catalyst Producers in China	103
Table VII-2	Contact Details for the Major Petrochemical and Chemical Catalyst Producers in China	109

POLYMERIZATION CATALYSTS

TABLE OF CONTENTS

SECTION I. INTRODUCTION.....	1
SECTION II. EXECUTIVE SUMMARY	3
A. Polymer Market Overview and Polymerization Catalyst Market Status Quo..	4
B. Polymerization Catalyst Market Overview	6
C. Polymerization Catalyst Technology	7
D. Issues/Concerns, Opportunities/Threats and Recommendations	7
SECTION III. CHINA’S POLYMERIZATION CATALYST INDUSTRY	11
A. General	11
1. General Status of Polyolefin Products in China.....	11
a. Profile of China’s polyolefin industry	11
i. PE industry.....	11
ii. PP industry.....	14
b. Profile of polyolefin catalysts	18
i. PE catalysts.....	18
ii. PP catalysts	20
2. Status of Elastomers in China	22
a. Profile of China’s elastomer industry	22
b. Profile of elastomer catalysts	28
3. Status of PVC in China	29
a. Profile of China’s PVC industry	29
b. Overview of PVC initiators.....	31
4. Status of Polystyrene (PS) in China	34
a. Profile of China’s PS industry	34
b. Overview of PS initiators.....	38
5. Status of ABS Resin in China	39
a. Profile of China’s ABS resin industry	39
b. Overview of ABS resin initiators.....	40
6. Status of Polyester (PET) in China	41
B. Structure of the Polymerization Catalyst Sector.....	42

1.	Profile of polyolefin catalyst producers and research institutions.....	42
a.	SCC Beijing AODA Division	45
b.	Renqiu Lihe Technology Co., Ltd.....	45
c.	Yingkou Xiangyang Catalysts LLC	46
d.	Shanghai Leader Catalyst Co., Ltd.	46
e.	Zibo Xinsu Chemical Co., Ltd.	47
f.	Liaoning Dingjide Petrochemical Co., Ltd.	47
g.	Shanghai Süd-Chemie Catalysts Co., Ltd.	47
2.	Profile of elastomer catalyst producers and research institutions	47
3.	Profile of PVC initiator producers and research institutions.....	52
4.	Profile of PS initiator producers and research institutions	53
5.	Profile of ABS initiator producers and research institutions.....	54
6.	Profile of PET catalyst producers and research institutions.....	55
C.	Analysis of Market Supply/Demand Balance	55
1.	Analysis of the Market Supply/Demand Balance of Polyolefin Catalysts	55
a.	China's polyolefin catalyst production situation.....	55
b.	China's polyolefin catalyst consumption situation.....	57
c.	China's polyolefin catalyst market supply and demand balance analysis.....	58
2.	Analysis of the Market Supply/Demand Balance of Elastomer Catalysts	58
a.	China's elastomer catalyst production situation.....	58
b.	China's elastomer catalyst consumption situation	60
c.	China's elastomer catalyst supply and demand balance analysis	60
3.	Analysis of the Market Supply/Demand Balance of PVC Initiators.....	60
4.	Analysis of the Market Supply/Demand Balance of PS Initiators	63
5.	Analysis of the Market Supply/Demand Balance of ABS Initiators.....	67
6.	Analysis of the Market Supply/Demand Balance of PET Catalysts	68
D.	Price Change and Affecting Factors.....	70
1.	Price Change of Polyolefin Catalysts in China and Affecting Factors	70
a.	Movement of polyolefin catalyst prices in China	70
b.	Factors that affect the polyolefin catalyst price changes	71
2.	Price Change of Elastomer Catalysts in China and Affecting Factors.....	71

E.	Market Growth and Affecting Factors.....	72
1.	Growth of polyolefin catalyst market in China and affecting factors	72
a.	Growth of polyolefin catalyst market	72
b.	Affecting factors	72
i.	Status quo and forecast of the demand for polyolefins.....	72
ii.	New and proposed polyolefin projects in China.....	73
2.	Market growth of elastomer catalysts in China and affecting factors.....	76
a.	Butadiene rubber catalyst market growth and its influencing factors.....	76
b.	EPR catalyst market growth and its influencing factors	78
c.	Isoprene rubber catalyst market growth and its influencing factors	80
3.	China's PVC initiator market growth and affecting factors.....	81
a.	PVC initiator market growth.....	81
b.	Affecting factors	82
4.	China's PS initiator market growth and affecting factors.....	84
a.	PS initiator market growth	84
b.	Affecting factors	85
5.	China's ABS initiator market growth and affecting factors.....	87
a.	ABS initiator market growth.....	87
b.	Affecting factors	87
6.	China's PET catalyst market growth and affecting factors.....	88
a.	PET catalyst market growth.....	88
b.	Affecting factors	89
F.	Imports and Exports.....	90
1.	Imports and exports of polyolefin catalysts	90
a.	Imports of polyolefin catalysts.....	90
b.	Exports of polyolefin catalysts.....	91
2.	Imports and exports of elastomer catalysts	91
a.	Imports of elastomer catalysts.....	91
b.	Exports of elastomer catalysts.....	91
G.	Polymerization Catalyst Technologies	91
1.	Polyolefin catalyst technology	91
a.	Mature technology	91
i.	BCH catalyst.....	91

ii.	BCE catalyst	92
iii.	SCG-1 series catalysts	92
iv.	SCG-3/4/5 series catalysts	93
v.	SLC-type catalysts	94
vi.	N series catalysts	94
vii.	DQ catalyst	96
viii.	CS series catalysts	97
b.	New technologies	100
i.	JM-1 catalyst	100
ii.	BCE catalyst	100
iii.	SLC-B catalyst	101
iv.	SST non-metallocene PE catalyst	101
v.	SAL catalyst	102
vi.	PSP-01 spherical catalyst	102
vii.	PC-MAX-120	102
viii.	DQC series catalyst	103
ix.	NDQ catalyst	103
x.	Spherical PP catalyst	103
xi.	Metallocene catalyst	104
2.	Elastomer catalyst technology	104
a.	Butadiene rubber catalyst technology	104
b.	Rare earth-based isoprene rubber catalyst technology	106
c.	EPR catalyst technology	108
SECTION IV. ISSUES AND CONCERNS FACED BY CHINA'S POLYMERIZATION CATALYST INDUSTRY		111
A.	Issues	111
B.	Concerns	112
SECTION V. OPPORTUNITIES AND THREATS FACED BY CHINA'S POLYMERIZATION CATALYST INDUSTRY		115
A.	Opportunities	115
B.	Threats	116
SECTION VI. STRATEGIES AND RECOMMENDATIONS		119
A.	Industry Landscape and Forecast	119
B.	Strategies and Recommendations	120

TABLES

Table II-1	Output, Import, Export and Consumption of the Six Major Types of Synthetic Resins in China in 2011	4
Table II-2	Polymerization Catalyst Supply and Demand Balance in China in 2011	6
Table II-3	Worldwide Catalyst Market - Polymerization (US \$ MIL).....	6
Table III-1	China's Major PE Producers in 2011	12
Table III-2	China's Major PP Producers in 2011.....	15
Table III-3	Types of Polyolefin Catalysts in China	21
Table III-4	China's Major Elastomer Producers in 2011	24
Table III-5	Types of Elastomer Catalysts in China.....	28
Table III-6	China's Major PVC Producers in 2011	30
Table III-7	Major GPPS and HIPS Producers in China in 2011	35
Table III-8	Major EPS Manufacturers in China in 2011.....	36
Table III-9	Major ABS Resin Producers in China in 2011	39
Table III-10	Major PET Manufacturers in China in 2011	42
Table III-11	Major Polyolefin Catalyst Producers and Research Institutions in China.....	43
Table III-12	Contact Details for Major Polyolefin Catalyst Producers and Research Institutions in China	44
Table III-13	Major Elastomer Catalyst Producers and Research Institutions in China.....	48
Table III-14	Contact Details for Major Elastomer Catalyst Producers and Research Institutions in China	49
Table III-15	Major PVC Initiator Producers and Research Institutions in China....	52
Table III-16	Major PS Initiator Producers and Research Institutions in China	53
Table III-17	Major ABS Initiator Producers and Research Institutions in China....	54
Table III-18	Major PET Catalyst Producers in China.....	55
Table III-19	China's PE Catalyst Production Situation in 2011	56
Table III-20	China's PP Catalyst Production Situation in 2011	56
Table III-21	China's Polyolefin Catalyst Consumption Situation in 2011	57
Table III-22	China's Polyolefin Catalyst Supply and Demand Balance Analysis	58
Table III-23	China's Elastomer Catalyst Production Situation in 2011	59
Table III-24	China's BR/EPR/IR Catalyst Consumption in 2011	60

Table III-25	China's Elastomer Catalyst Supply and Demand Balance Analysis in 2011	60
Table III-26	Production Situation of China's Major PVC Initiator Producers	61
Table III-27	Production Situation of China's Major PS Initiator Producers.....	64
Table III-28	Production Situation of China's Major ABS Initiator Producers	68
Table III-29	China's Polyester Catalyst Production Situation in 2011	70
Table III-30	Polyolefin Catalyst Prices in China in Recent Years.....	71
Table III-31	Projections of Chinese Demand for Polyolefin Catalysts, 2011-2016	72
Table III-32	China's Polyolefin Resin Consumption Growth Situation in Recent Years, 2011-2016.....	73
Table III-33	New and Proposed Polyolefin Projects in China in Recent Years	74
Table III-34	New and Proposed Butadiene Rubber Projects in China.....	77
Table III-35	New and proposed EPR Projects in China.....	79
Table III-36	New and Proposed Isoprene Rubber Projects in China	81
Table III-37	China's New and Proposed PVC Projects	83
Table III-38	China's New and Proposed PS Projects	85
Table III-39	China's New and Proposed ABS Resin Projects	88
Table III-40	China's PET Catalyst Demand Forecast, 2011-2016	88
Table III-41	China's New and Proposed PET Projects	89
Table III-42	China's Polyolefin Catalyst Imports in 2011.....	90
Table III-43	China's Polyolefin Catalyst Exports in 2011.....	91
Table III-44	Performance Indicators of N catalysts	96
Table III-45	Performance Indicators of DQ catalyst.....	97
Table III-46	Characteristics and Performance Indices of CS-1 catalyst	98
Table III-47	Characteristics and Performance Indices of CS-2 catalyst	99
Table III-48	Catalytic Activity of Elastomer Catalysts.....	109

ENVIRONMENTAL CATALYSTS

TABLE OF CONTENTS

SECTION I. INTRODUCTION.....	1
SECTION II. EXECUTIVE SUMMARY	3
A. Issues Affecting Environmental Catalysts in China	3
B. Emission Pollution in China – Current Status	5
1. Mobile Pollutant (Motor Vehicle) Catalysts	5
2. Stationary Pollutant Catalysts	8
a. SCR catalysts	8
b. Claus desulfurization catalysts.....	11
C. Other Areas/Technologies in Emission Control	12
1. Catalysts for Waste Water Treatment	12
2. Photo-catalysts.....	12
3. Fuel Cells.....	13
D. Remaining Challenges in Emission Control.....	13
SECTION III. ENVIRONMENTAL CATALYST INDUSTRY IN CHINA.....	15
A. General.....	15
1. Present Status of Emission Pollution in China.....	16
2. Introduction of Environmental Catalysts	19
a. Mobile pollutant catalysts	19
i. Automobiles.....	19
ii. Motorcycles	20
b. Stationary pollutant catalysts	21
i. Denitration catalysts	21
ii. Desulfurization catalysts.....	22
3. Laws, Regulations and Policies in China	22
a. Mobile pollutant catalysts	22
i. Announcement of the State Environmental Protection Administration	22
ii. National III and IV emission standards for light vehicles and dates for implementation	23
iii. National pollutant emission standards for motorcycles.....	23

b.	Stationary pollutant catalysts	24
i.	Total emission amount control plan of the State Council for major pollutants during the 12 th Five-year Plan period.....	24
ii.	Standard for Atmospheric Pollutant Emission in Thermal Power Plants.....	27
iii.	Technical Code for Flue Gas Denitration in Thermal Power Plants: Selective Catalytic Reduction Process.....	27
iv.	Technical Code for Flue Gas Denitration in Thermal Power Plants: Selective Non-Catalytic Reduction Process	27
v.	Guideline for Major High-Tech Commercialization Sectors with Development Priority (2011).....	28
vi.	Technical Standard for “Coal Combustion Flue Gas Denitration Technologies and Equipment.....	28
vii.	Methods for the Calculation of the N ₂ O Emission Amount in Nitric Acid Producers”	28
viii.	Standard for Atmospheric Pollutant Emission in the Cement Sector	29
B.	Structure of the Sector	33
1.	Mobile Pollutant Catalysts	33
2.	Stationary Pollutant Catalysts	35
a.	SCR catalysts	35
b.	Desulfurization catalysts	35
C.	Analysis of the Market Supply/Demand Balance.....	36
1.	Production of Environmental Catalysts.....	36
a.	Mobile pollutant catalysts	36
b.	Stationary pollutant catalysts	43
i.	Total output of SCR catalysts	43
ii.	Producers of SCR catalysts.....	43
iii.	Contact details for producers of SCR catalysts	48
iv.	Production of Claus desulfurization catalysts.....	50
v.	Contact details for major producers of Claus desulfurization catalysts.....	52
2.	Consumption and Consumers of Environmental Catalysts	53
a.	Mobile pollutant catalysts	53
i.	Output of motor vehicles	53
ii.	Consumption of catalysts.....	53

b.	Stationary pollutant catalysts	56
i.	Consumption of SCR catalysts	56
ii.	Downstream users of SCR catalysts	57
iii.	Consumption of desulfurization catalysts.....	60
3.	Analysis of Supply/Demand Balance.....	62
a.	Mobile pollutant catalysts	62
b.	SCR denitration catalysts	62
c.	Desulfurization catalysts	62
D.	Imports and Exports.....	63
1.	Mobile Pollutant Catalysts	63
2.	Stationary Pollutant Catalysts	64
E.	Price Changes and Factors Affecting Price	65
F.	Market Growth and Affecting Factors.....	66
1.	Mobile Pollutant Catalysts	66
a.	Supply projection	66
b.	Demand projection.....	66
2.	Stationary Pollutant Catalysts	67
a.	SCR catalysts	67
b.	Claus desulfurization catalysts.....	70
G.	Environmental Catalyst Technologies.....	71
1.	Mobile Pollutant Catalyst Technologies	71
2.	SCR Catalyst Technologies.....	71
3.	Claus Catalyst Technologies	72

SECTION IV. ISSUES AND CONCERNS IN THE CHINESE ENVIRONMENTAL CATALYST INDUSTRY 75

A.	The Chinese Approach	75
B.	Problems and Points of Attention in Mobile Emission Catalysts.....	76
1.	Mobile Emission Catalysts.....	76
a.	Catalytic conversion rate.....	76
b.	Catalyst deactivation	76
c.	Cold start	76
d.	Cost	76
e.	Readjustment orientation of industrial policies	76

2. Stationary Pollutant Catalysts	77
a. Development orientation of environmental protection policies.....	77
b. Enforcement of environmental protection policies	77
c. Safety problem in operation	77
SECTION V. OPPORTUNITIES AND THREATS TO THE CURRENT SITUATION IN THE CHINESE ENVIRONMENTAL CATALYST INDUSTRY.....	79
A. Opportunities	79
1. Mobile Pollutant Catalysts	79
a. Implementation of standards for new vehicles.....	79
b. Implementation of standards for vehicles in service.....	79
c. Brisk demand growth of automobiles promoted by economic growth	80
d. Stricter environmental protection policies and higher motor vehicle tail gas emission standards	80
e. Enhanced awareness of enterprises and society in environmental protection.....	81
f. Standards for oil product quality lagging behind standards for automobile emission, a negative factor for the implementation of high standards for motor vehicle tail gas emission	81
2. Stationary Pollutant Catalysts	81
a. Policy promoting factors	81
b. Market promoting factors.....	84
B. Threats	85
1. Expansion of Capacity and Upgrading of Domestic Technology	85
2. Entry of New Foreign Companies	86
3. Lack of Denitration Catalyst Production Technologies with Intellectual Property Rights and Redundant Introduction of Foreign Technologies.....	86
4. Need of Standardized Management to Chaotic Competition in the Denitration Catalyst Market	87
SECTION VI. STRATEGIES AND RECOMMENDATIONS.....	89

FIGURES

Figure III-1	Shapes of Automobile Three-way Ceramic-Support Catalysts	20
Figure III-2	Shapes of Motorcycle Metal-Support Catalysts.....	21
Figure III-3	Shapes of SCR Catalysts.....	22

TABLES

Table II-1	Worldwide Market for Pollution Control Catalysts by Application, 2009-2017 (US\$MIL)	4
Table II-2	Major Producers and Capacities of Motor Vehicle Catalysts	6
Table II-3	Supply/Demand Balance of Motor Vehicle Ceramic-Support Catalysts	6
Table II-4	Demand Projection of Motor Vehicle Catalysts	7
Table II-5	Major Producers and Capacities of SCR Catalysts in China	8
Table II-6	Consumption Trend of SCR Catalysts in China, 2000-2011	9
Table II-7	Market Prospect of SCR Catalysts in Thermal Power Plants of China, 2011-2016.....	10
Table II-8	Major Producers and Capacities of Claus Desulfurization Catalysts in China.....	11
Table II-9	Supply/Demand Balance of Claus Catalysts in China and Projection	12
Table III-1	Total Amount and Output of Civil Automobiles and Motorcycles in China	16
Table III-2	Output of Thermal Power in China	17
Table III-3	Emission Amount of Major Pollutants in China	19
Table III-4	Emission Limits of Pollutants in China.....	24
Table III-5	Dates for Implementation of Standards in China	24
Table III-6	Total Emission Amount Control Plan for NO _x and SO ₂ in Various Provinces of China During the 12 th Five-year Plan Period	25
Table III-7	Laws, Regulations and Policies Related to NO _x and SO ₂ Emission Standards in China.....	29
Table III-8	Ownership of Major Producers of Motor Vehicle Catalysts.....	33
Table III-9	Ownership of Major Producers of SCR Catalysts.....	35
Table III-10	Ownership of Major Producers of Desulfurization Catalysts	36
Table III-11	Major Producers and Capacities of Motor Vehicle Catalysts	36
Table III-12	Contact Details for the Major Producers of Motor Vehicle Environmental Catalysts in China.....	40
Table III-13	Production of SCR Catalysts in China, 2006-2012.....	43
Table III-14	Major Producers and Capacities of SCR Catalysts in China	44
Table III-15	Contact Details for Major Producers of SCR Catalysts in China ...	48
Table III-16	Major Producers and Capacities of Claus Desulfurization Catalysts in China.....	51

Table III-17	Contact Details for Major Producers of Claus Desulfurization Catalysts in China.....	52
Table III-18	Total Output of Automobiles and Motorcycles in China.....	53
Table III-19	Consumption of Motor Vehicle Ceramic-Support Catalysts	55
Table III-20	Producers and Capacities of Motor Vehicle Tail Gas Catalytic Converters in China.....	55
Table III-21	Consumption Trend of SCR Catalysts in China During 2000-2011.....	57
Table III-22	Volume of Denitration Projects Completed by Major Environmental Protection Companies in China in 2011	58
Table III-23	Major End Users of SCR Catalyst Producers in China in 2012.....	59
Table III-24	Consumption Trend of Claus Desulfurization Catalysts in China During 2006-2011	61
Table III-25	Major Users of Desulfurization Catalysts in China in 2011	61
Table III-26	Supply/Demand Balance of Motor Vehicle Ceramic-support Catalysts, 2006-2016.....	62
Table III-27	Supply/Demand Balance of Claus Desulfurization Catalysts in China During 2006-2016.....	63
Table III-28	Imports and Exports of Motor Vehicle Catalysts in China, 2006-2011.....	63
Table III-29	Imports and Exports of SCR Catalysts in China, 2008-2012.....	64
Table III-30	Imports and Exports of Desulfurization Catalysts in China, 2006-2011.....	65
Table III-31	Demand Projection of Motor Vehicle Catalysts, 2006-2016	67
Table III-32	SCR Catalyst Projects Being Constructed or Planned for Construction in China.....	68
Table III-33	Market Prospect of Thermal Power Station SCR Catalysts in China, 2011-2016.....	69
Table III-34	Consumption of Claus Desulfurization Catalysts in China, 2006-2016.....	70
Table III-35	R&D Trends in SCR Catalysts with Intellectual Property Rights in China	72
Table V-1	Average Annual Growth of GDP in China and the Total Amount and Output of Civil Automobiles, 2006-2011.....	80