The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications – Update 2019

- STUDY PROPOSAL -

A Multi-Client Study Series

April 2019

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I. BACKGROUND

Produced as a series of two reports - the first in 2005 and the initial Update in 2013 - The Catalyst Group Resources' (TCGR's) and the China National Chemical Information Center's (CNCIC's) ***"The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications"*** were historic, insightful, and actionable documents capturing catalyst market sizes, growth rates and participants in China. The multi-client study series were 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.

Since it has been nearly six (6) years since the most recent Update (in 2013), the catalytic process industries in China now need to be re-analyzed and segment reports updated in light of dramatic changes in technology, supply, security and political/ regional influences. Due to the important shifts which have occurred, TCGR, along with CNCIC, is proposing to launch another four volume update, entitled ***"The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications - Update 2019."*** This ***"Update 2019"*** will delineate important changes to the landscape, the economics and the industry implications based on technology advances and manufacturing/production capabilities that have taken place in China over the past 6 years. This study has global strategic, commercial and technological uses and provides a serious guide for industry executives in business decision-making.

II. EXCERPTS/HIGHLIGHTS FROM THE 2013 STUDY SERIES

As an indication of the breadth/depth of the coverage and assessments delivered in earlier versions of the report, presented below are examples of findings in each of the four (4) segments from the 2013 report series:

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., Clariant, Grace, BASF, Johnson Matthey, Umicore and others.

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- 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.

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. China will consume more than 200 kt of petrochemical catalysts by 2019, and will report annual growth rates well above 10%.

- 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." Trends spell opportunity for growth by Western catalyst suppliers who produce domestically.

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In polyolefin catalysts:

- 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.

In environmental catalysts:

- 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. It is estimated that the potential energy conservation via technological and economic changes will be more than 400 million tons of standard coal 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.

III. THE NEED FOR THIS STUDY "UPDATE"

The technical, commercial and strategic/competitive situations in China have progressed rapidly since our last report series six years ago. The transformation from a managed economic system into one incorporating more market-driven factors has resulted in both opportunities and challenges, for both western and Chinese companies alike. The Chinese companies are operating to address current demands as well as plan for future needs, with consideration to the country's strategic priorities and incentives. The implications affect all segments in catalyst

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development and production as well and process licensing, including their application in refining, petrochemical/chemical, polymerization and environmental segments. Over the next decade, this will yield certain opportunities for global as well as indigenous suppliers if they can anticipate - and take advantage of - the unique events and dynamics (including relationships, both ownership and informal) in their respective industries.

Foreign investment capital in the hundreds of billions of dollars range has already been deployed by the global chemical majors, including Shell, ExxonMobil, and BP as well as the catalyst/licensing majors BASF, Clariant, Albemarle, Haldor Topsoe, Honeywell UOP, Johnson Matthey, W.R. Grace, etc. Concurrently, the demand and sophistication levels of the Chinese majors are also rapidly growing the development and production/consumption of catalysts. Whereas in the past the initial demand for new technology and/or catalyst supply was served mostly via Western companies, they are increasingly being replaced by domestically-based Chinese producers. Nonetheless, opportunities remain for those with an understanding of the intricacies of the supply chain, relationships and market requirements.

To this day, there are few areas of the globe with 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 (including partnerships) 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 earlier two study series completed in 2005 and 2013, the ***"Update 2019"*** is being 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" will work inside China and gather locally (on the ground) information on the supply/demand, producers and the structure and changes (trends) expected over the next 5-10 years. Secondly, TCGR/CNCIC will document the supply chain by process and relationships between organizations. In addition to the statistical information, TCGR/CNCIC will provide local and outside interpretation of the business in catalysts (as an industry) and how the end-users are driving change.

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In this series of four (4) catalyst industry reports, the Chinese catalyst and catalytic process industries will be 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 will be a "stand alone" but integrated strategic assessment of the current situation in China. It will offer executive level guidance on opportunities and threats, with supporting data to enable further analyses in-house. Reports will document market sizes, suppliers and buyers, industry structure, price trends and trade flows as well as technological developments and the competitive landscape. Analyses will be provided so that resultant opportunities are identified and characterized, including notable hurdles. Conclusions and recommendations will be made with specific action steps to be considered for short-term implementation.

In this approach, TCGR will combine 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 will incorporate data assembled by CNCIC, collected via internal PRC sources as well as primary market research surveys, and will assess 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 will 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, will allow 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
  - Consumers and Consumption
  - Market Drivers
  - Forecast of Market Trends
  - Manufacturers and Output
  - Trade (Imports and Exports)
  - Technology Development
- Issues/Concerns
- Opportunities/Challenges
- Conclusions

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Particular attention will be 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 will also be highlighted differences between methods and operations of Chinese companies relative to Western and/or other Asian participants.

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

A proposed Table of Contents for a prototypical catalyst segment report is presented on the following page; each of the four segment reports follows similar guidelines, although some segment-specific content requires minor differences, and will be 75 - 100 pages in length.

> **In order to heighten the value-added from study participation, TCGR/CNCIC will work with "charter" subscribers (i.e., those who sign up for the study by Fri., June 7th, 2019) in order to define the scope of the report by delineating areas of particular interest for inclusion in each assessment.**

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PROTOTYPE TABLE OF CONTENTS*

– **similar outlines to be used for each of the four (4) catalyst industry segments** – including: Refining; Petrochemical/Chemical; Polymerization; and Environmental (Stationary and Mobile)

I. INTRODUCTION, BY SEGMENT*

A. The changing role of China in the global catalytic processes industries
B. The issues worthy of assessment and resulting opportunities for advantage

II. EXECUTIVE SUMMARY, BY SEGMENT*

III. THE CATALYST INDUSTRY IN CHINA, BY SEGMENT*

(A detailed description and assessment of the make-up of catalyst production, supply and usage in the PRC, with emphases on unique aspects and differences between Western and developed/mature catalytic process industries)

- A. Industry Overview
- B. Current Status
- C. Segment Analysis (by Sub-segment)
  1. Introduction
  2. Manufacturers and Output
  3. Consumers and Consumption
  4. Trade (Imports and Exports)
  5. Market Drivers
  6. Technology Development
  7. Forecast of Market Trends
- D. Issues/Concerns
- E. Opportunities/Challenges
- F. Conclusions

IV. ISSUES AND CONCERNS, BY SEGMENT*

(Each application of catalysts faces new challenges due to China's changing role; increasing demand for materials, new regulations and opportunistic producers/suppliers are reshaping the competitive landscape)

V. BUSINESS OPPORTUNITIES AND THREATS TO CURRENT SITUATION, BY SEGMENT*

(Each application has its own "drivers," affecting decisions at the tactical and strategic level. The changing situation presents threats and opportunities which are specific to the players, their markets, etc.)

VI. STRATEGIES AND RECOMMENDATIONS, BY SEGMENT*

(The landscape in each segment defines the appropriate market approach, product breadth/depth requirements and technology deployment; TCGRs' perspectives provides guidance on "next steps")

** Charter members (those who sign up for the study before Fri., June 7th, 2019) will have the opportunity to work with TCGR/CNCIC in defining the scope of the report by delineating areas of particular interest for inclusion in the assessment.*

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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 more than 35 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 more than 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 will conduct the local data collection in China, through sources in the PRC as well as through primary market research interviews. It will also provide 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/CNCIC.

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 will provide subscribers unparalleled insights into an increasingly important area.

Each segment report will be 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 will follow a prototypical outline and can be purchased individually or as a group (of 2, 3 or all 4 reports).

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Report Segment	Projected Availability
I. Refining Catalysts in PRC – Update 2019	September 2019
II. Petrochemical/Chemical Catalysts in PRC – Update 2019	October 2019
III. Polymerization Catalysts in PRC – Update 2019	October 2019
IV. Environmental Catalysts in PRC – Update 2019	November 2019

Participation	Price
Each (1) Catalyst Segment in PRC Report	US$15,500
Any two (2) Catalyst Segment Reports	US$23,500
Any three (3) Catalyst Segment Reports	US$29,500
All four (4) Catalyst Segment Reports	US$34,500
Each report segment in PDF format (in addition to subscription price)	US$1,000

The segment reports will become available on a rolling basis during the third and fourth quarters of 2019. The first segment, addressing Refining Catalysts, will be ready in September 2019, with each of the remaining segment reports becoming available in 3-4 week increments thereafter, with the final segment report to be completed by November 2019.

- Notice to Subscribers of the 2013 Multi-Client Study Series -

Due to the complementary nature of this study series to the one completed in 2013, 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 2013 multi-client series.

The study series, ***"The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications – Update 2019,"*** is available on a subscription basis from The Catalyst Group Resources (TCGR) and the China National Chemical Information Center (CNCIC).

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____ Please enter our order for your report series entitled ***"The Catalytic Process Industries in China - Markets, Technologies & Strategic Implications – Update 2019,"*** to be completed, on a segment-by-segment basis, in Q3-Q4, 2019. The cost of one of the "segment reports" is US$15,500; two segments are US$23,500; three segments are US$29,500 and all four segment reports are US$34,500. The segment reports we are ordering are:

Segment Report Title	Selected (mark w/ "X")	Expected Completion
Refining Catalysts in PRC	__________	Sept. 2019
Petrochemical/Chemical Catalysts in PRC	__________	Oct. 2019
Polymerization Catalysts in PRC	__________	Oct. 2019
Environmental Catalysts in PRC	__________	Nov. 2019

____ 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 2013 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.

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