

**THE INDUSTRIAL ADSORBENTS BUSINESS:  
COMMERCIAL STRATEGY, TECHNICAL AND R&D ASSESSMENT  
IN REFINING, CHEMICALS/SYNGAS, NATURAL GAS AND INDUSTRIAL GASES**

**MULTI-CLIENT STUDY PRESENTATION**

**(Study completed July 2013)**



# **THE INDUSTRIAL ADSORBENTS BUSINESS: COMMERCIAL STRATEGY, TECHNICAL AND R&D ASSESSMENT IN REFINING, CHEMICALS/SYNGAS, NATURAL GAS AND INDUSTRIAL GASES**

## **I. INTRODUCTION**

Separations and purifications within industrial processes are becoming more demanding, thus more important than ever! This is the result of some very important trends. First the source of feedstocks, whether petroleum (heavy oil and Canadian tar sands) or biologically based (cellulosic), to produce fuels and chemicals are presenting increasingly more challenges, whereas the need for purer intermediates and final products continues to rise. This is due in part to higher yield, more sophisticated and economic manufacturing. Second is the more recent recognition as well as that separation/purification is a very energy demanding requirement. In today's expectations for improved costs, as well as reduced GHG i.e. CO<sub>2</sub> reduction, it has become obvious that saving energy and reducing the CO<sub>2</sub> footprint has become a simultaneous "win-win" in today's competitive industrial business environment. Therefore significant attention is being placed on materials and energy improvements.

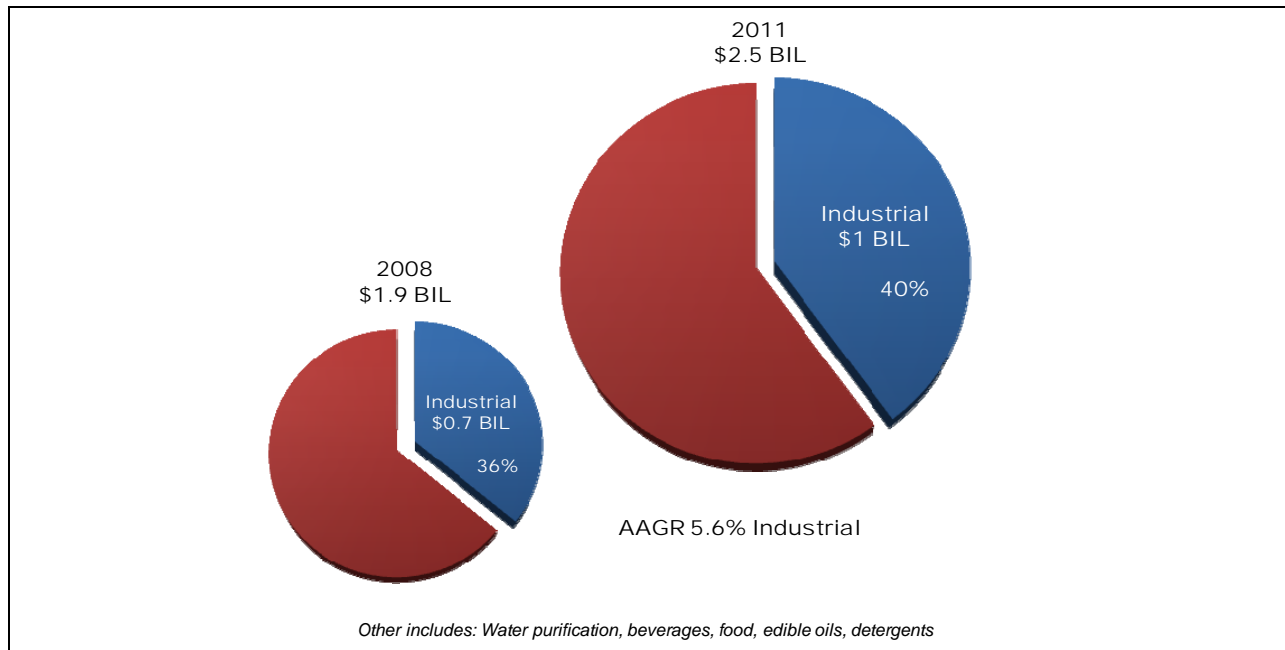
Industrial adsorbents, whether part of a composite membrane or not, play an increasingly vital role in today's state-of-art manufacturing. However, they seem to have garnered less attention, perhaps because catalysis and reactor engineering is more exciting! The market by many is considered mature. Nonetheless, both scientifically and industrially, they are poised to play an increasingly value-added role! To date, there have not been sufficiently reliable business studies which characterize, as well as document the current size and growth of this market, in part because process licensors within OECD dominated the applications with packaged systems, i.e. wrapped up as part of the process license. Now that this business opportunity is viewed as a global application, it quickly becomes apparent there is significant opportunity to garner value, through two actions: (1) consolidation and improved supply logistics; and (2) by providing improved cost/performance solutions. Many country markets outside of OECD are highly fragmented and do not have optimized enduser markets.

In this study, The Catalyst Group Resources (TCGR) provides industrial practitioners with the first independent market application build-up analysis performed in the last fifteen years. It has been assembled by a team of industry professionals with over one hundred combined years of commercial experience, from natural gas, industrial gases and process licensing businesses. Subscribers will appreciate the challenges presented by such a fragmented marketplace, acknowledging the know-how and the methodical approach used to complete this benchmarking work.

## **II. BACKGROUND**

While adsorbents find diverse uses in water purification, beverage, food, health and environmental applications, industrial adsorbents are critical materials to the separation, purification and dehydration of hydrocarbons and industrial gases. With the increased emphasis on higher quality products, fuels and the improvement of energy efficiency and contaminant control, adsorbents and improved processes to use them are becoming even more important than ever (see Figure 1).

**Figure 1**  
**Industrial Adsorbents Market: \$1 BIL in 2011; 5.6% AAGR**



Traditional adsorbents include natural materials (e.g. clays, activated carbon and silicas), but increasingly they are synthetically engineered products such as zeolite molecular sieves (ZMS), modified aluminas, and metal oxides. These molecular and functionally modified surfaces provide increased selectivity for contaminant removal or molecular bonding. Increasing performance demands are requiring value-added product approaches and there is a continual search for improvements, which stimulates R&D for new materials.

In the refining, chemicals/syngas, natural gas and industrial gases segments, known as the “process industries,” there are a number of global suppliers as well as a number of niche players, as shown in Table 1. These include process licensors where specialties demand royalties (e.g. UOP/Honeywell or Axens), as well as suppliers of advanced materials commanding premiums but also commodities.

**Table 1**  
**Large Adsorbent Suppliers, by Material**

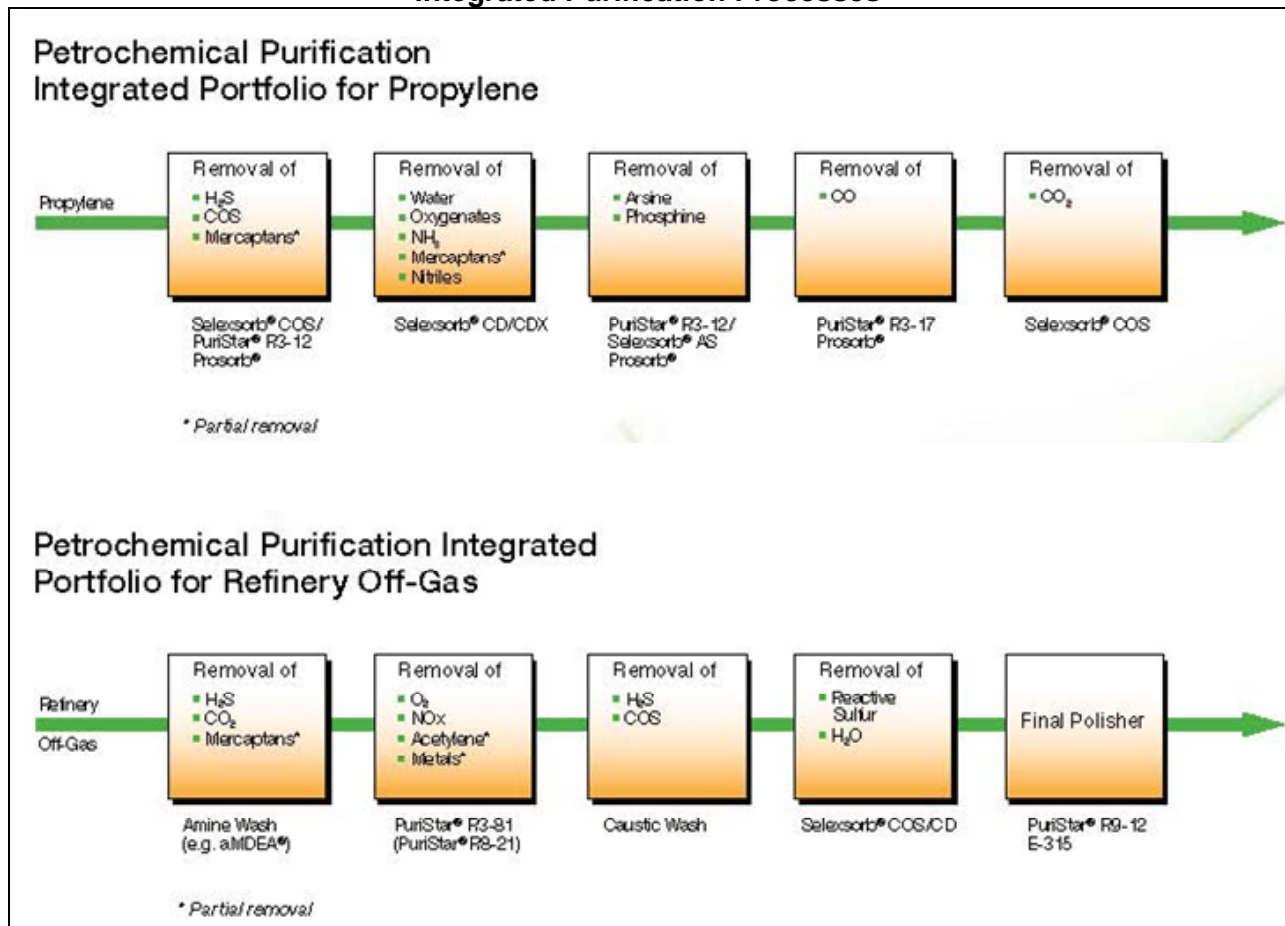
Alumina	Δ	Leader				Δ		Δ			Δ	Δ	Δ			
Mole Sieve	Leader	Δ		Δ	Δ	Δ		Δ	Δ	Δ						
Silica		Δ		Leader		Δ			Δ							
Clay		Leader	Δ													
Metal Oxide	Δ	Δ	Leader				Δ									
Activated Carbon										Δ				Δ	Δ	
	UOP	BASF	Clariant	Grace	Uitikon	Petrogas	JMI	Axens	PQ	CECA (Arkema)	Eurosupport	Sumitomo	Porocel	Norit	Calgon	Mead Westvaco

Information from suppliers is openly provided for important applications in refining, petrochemicals and natural gas. However, little is readily available for the practitioner/enduser to compare the relative merits of products offered between suppliers. In addition, from a supplier's competitive benchmarking perspective, little is easily available for comparative purposes between suppliers' equivalents. This proprietary industrial nature and complexity has significant implications on technological and commercial progress, and is a major impetus for this study.

The Catalyst Group Resources' (TCGR's) study took a practical look at the processes, products and competitive offerings on a global basis. Its hands-on approach comes from its deep technical understanding of materials, as well as the engineering of the processes, with their advantages/disadvantages compared to alternative approaches. To highlight these comparisons, we compared the leading licensed and/or industrially used adsorbent processes, with those in the development pipeline.

TCGR also completed a careful evaluation of how many of these processes are integrated – as shown by the two BASF process flow schemes in Figure 2 below. This is highlighted because the complete packaging of process systems is a market trend as larger players push for increased market share.

**Figure 2**  
**Integrated Purification Processes**



Source: BASF

An improved understanding will assist both suppliers and major endusers in the adsorbents marketplace. **Appreciating the globalization trend will help define new market application opportunities for existing players. Evolving technology advances will also lead to an expanded market. For example, CO<sub>2</sub> capture is a large developing application to control and monetize GHG. What is the possible role for adsorbents in this new application?**

### **III. THE NEED FOR THE STUDY**

While a number of smaller industry studies are available that document and provide the market sizes and growths of individual materials such as aluminas, activated carbons, zeolites, etc., there have been no studies to TCGR's knowledge that specifically focus on providing an in-depth perspective on the industrial hydrocarbon/gases adsorbent processes and process licensing market, covering all available competing adsorbents. **This capability is a unique skill and knowledge base that only TCGR can assemble.**

In fact, the last similar report entitled the **"Molecular Sieve Adsorbent Industry - Commercial Strategy and New Business Development Assessment"** was completed in 1989 by Catalyst Consultants, Inc. (the predecessor of TCGR). Our foundations from ex Union Carbide employees provide the foundations for deep zeolite and materials industry knowledge. There is a need for this timely study to benchmark the progress, as well as document the commercial opportunities, available for the future.

Improved adsorbent separations are increasingly vital to process cost improvements and energy efficiency. Both feedstock and energy costs are rising at the same time that more stringent industrial environmental regulations are being enacted, including CO<sub>2</sub>/GHG emissions reductions. This is also providing impetus to improve feedstock pre-treatment and post-treatment standards.

Alternatives to and hybrid systems will continue to compete against adsorbent separations, including membranes, adsorption solutions and other catalytic destruct systems. Understanding this balance will be important to investment decisions. As a result, there is a significant need, as well as opportunities to be analyzed in this growing commercial application globally, including assessing consolidation.

This newly updated and expanded report **"The Industrial Adsorbents Business: Commercial Strategy, Technical and R&D Assessment in Refining, Chemicals/Syngas, Natural Gas and Industrial Gases"** complements an ongoing portfolio of similarly well received studies The Catalyst Group Resources (TCGR) has delivered to clients over recent years. This growing experience demonstrates TCGR's unique capability, resources and expertise to deliver exceptional insight.

Recent multi-client studies and current membership-directed programs include:

- **The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications – Update 2013** (completed as a series of four segments in April- June, 2013)
- **GTL/XTL: An Assessment of the Technologies, Business and Competitive Landscape, 2010 to 2020** (October 2012).
- **Syngas Production and Conversion to Products – Technology and Commercial Update 2011** (June 2011).

- **Efficiency Gains Through Catalyst and Process Technology Advancements in the Refining and Petrochemical/Chemical Industries** (January 2010).
- **Integration of Biofuels ‘Inside the Refinery Gate’: Implementation, Logistics and Strategies-2009** (February 2009)
- **CO<sub>2</sub> Capture and Conversion (CO<sub>2</sub>CC) Program** - a membership-directed consortium for developing, monitoring and utilizing the “state-of-the-art” in technological progress and commercial implementation of CO<sub>2</sub> capture and conversion (ongoing).

#### **IV. SCOPE AND METHODOLOGY**

As depicted in the report’s actual Table of Contents on pages 6-13, TCGR’s study begins by completing an overview of the current industry players and the commercial landscape (Section III). It then provides a granular understanding of licensed vs non-licensed processes and products, applications and product properties, ending with supplier profiles and competitive SWOT’s of their offerings.

The market size and growth of the process industries 2012 -2017, is evaluated by key industry segments, e.g. refining, chemicals/syngas, natural gas, industrial gases and others (Section IV). Within those segments increased detail is provided on licensed process technology vs. non-licensed by delineating the status and advantages of competing processes. New market trends and key commercial developments are also identified.

Section V – Adsorbent Technical Developments – documents R&D and technical trends through patent analysis, as well as expert review and analysis of recent trade literature and conference proceedings. An outlook on which changes might be expected in the market from technical advances and their future impacts, beyond the status quo is highlighted.

Sections VI and VII provide TCGR’s unique knowledge and analysis from business development, barriers-to-entry and strategy perspectives. TCGR is known for its unique insights in identifying profit/money making opportunities for its clients. Of particular importance is an improved trend toward internationalization.

**TCGR’s unique background and historical development roots in adsorbents (ex Union Carbide) provides an unparalleled capability and skill level in this study area. Deep expertise in materials science and process engineering means the ability to provide insights beyond other sources, who do not have the industrial experience TCGR and our Dialog Group™ network can provide.**

For those that understand and appreciate this study undertaking, you will know how important and critically timely this evaluation is! We are standing at a critical crossroads as it pertains to industrial adsorbents. The next 5-10 years are certain to be telling. Thus, TCGR’s study is warranted.

*In order to heighten the value-added from study participation, TCGR worked with “charter” subscribers (i.e., those who signed up for the study prior to its formal “launch”) in order to define the scope of the report by delineating areas of particular interest for inclusion in the assessment. For details on the study scope, the report’s actual Table of Contents appears on the following pages.*

**THE INDUSTRIAL ADSORBENTS BUSINESS:  
Commercial Strategy, Technical and R&D Assessment in  
Refining, Chemicals/Syngas, Natural Gas and Industrial Gases**

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## V. QUALIFICATIONS

The Catalyst Group Resources, a member of The Catalyst Group, works with clients to develop sustainable competitive advantage in technology-driven industries such as chemicals, refining, petrochemicals, polymers, specialty/fine chemicals, biotechnology, pharmaceuticals, and environmental protection. We provide concrete proven solutions based on our understanding of how technology impacts business.

Using our in-depth knowledge of molecular structures, process systems, and commercial applications, we offer a unique combination of business solutions and technology skills through a range of client-focused services. Often working as a member of our clients' planning teams, we combine our knowledge of cutting-edge technology with commercial expertise to:

- Define the business and commercial impacts of leading-edge technologies
- Develop technology strategies that support business objectives.
- Assess technology options through strategy development, including:
  - Independent appraisals and valuations of technology/potential
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- Provide leading-edge financial methodology for shareholder value creation
- Lead and/or manage client-sponsored R&D programs targeted through our opportunity identification process.
- Provide leading information and knowledge through:
  - World-class seminars, conferences and courses
  - Timely technical publications

The client-confidential assignments conducted by The Catalyst Group include projects in:

- Reinventing R&D pipelines
- Technology alliances
- Technology acquisition
- Market strategy

We have built our consulting practice on long-term client relationships, dedication, and integrity. Our philosophy is clear and focused:

***We Provide the "Catalysts" for Business Growth by Linking Technology and Leading-Edge Business Practices to Market Opportunities***



## VI. DELIVERABLES AND PRICING

This report is timely and strategically important to those industry participants and observers considering investment, as well as to process technology companies evaluating the industrial adsorbent process markets. TCGR's report, based on technology evaluations, market assessments and interviews with key players goes beyond public domain information. As a result, subscribers are requested to complete and sign the "Order Form and Secrecy Agreement" on the following page.

The study, ***The Industrial Adsorbents Business: Commercial Strategy, Technical and R&D Assessment In Refining, Chemicals/Syngas, Natural Gas and Industrial Gases*** was completed in July 2013 and is available for immediate delivery in both print and electronic (PDF on CD) formats.

<b><i>The Industrial Adsorbents Business: Commercial Strategy, Technical and R&amp;D Assessment In Refining, Chemicals/Syngas, Natural Gas and Industrial Gases</i></b>	\$19,500
Report in PDF format, in addition to subscription price	\$1,000

## ORDER FORM AND SECRECY AGREEMENT

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Please enter our order for ***The Industrial Adsorbents Business: Commercial Strategy, Technical and R&D Assessment in Refining, Chemicals/Syngas, Natural Gas and Industrial Gases*** completed July 2013, as follows:

\_\_\_\_\_ ***The Industrial Adsorbents Business: Commercial Strategy, Technical and R&D Assessment In Refining, Chemicals/Syngas and Natural Gas*** for \$19,500.

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