Opportunities for Catalysts in the Refining and Petrochemical Industries: An Eight-year Forecast

Chapter One

Fuels Rev Up Catalyst Demand

1.1 Background to Report

This report, which focuses on analyzing and quantifying the opportunities for catalysts—including nanocatalysts—used in refining and petrochemicals production, couldn't come at a more relevant time. We find ourselves in a particularly interesting environment today, one that sets the scene for growth and development in the petrochemical catalysts industry. Rapidly growing population in developing countries combined with the demand for cleaner, environmentally friendly technologies, declining access to crude oil, and an economy that requires producers to re-think the way they do things (i.e. how do we make it cheaper and either avoid or minimize capital investment) has created fertile ground for catalysts.

The catalysts of interest for this report are primarily heterogeneous, and are to process crude oil in refineries and in the production of chemicals, such as the chemical intermediates ethylene and propylene. There are basic types of catalysts used in each of the refining process. For example, the most widely used FCC catalysts are based on amorphous and crystalline silica-alumina. Silica-alumina catalysts with rare earth metals are used for hydrocracking, and tungsten and molybdenum sulfides on alumina are used for hydrotreating.

Despite the well-developed nature of the refining and petchem industries and thus the catalysts used in these processes, there is still room for development. These developments will not mirror what occurred with the discovery of synthetic zeolites; instead, these will be tweaks and modifications that enable longer catalysts lifetimes, improved selectivity, and increased efficiency.

1.1.1 Growth in Established Markets

There are several factors at play to make this a strong market for catalysts producers. For the traditional refining processes, the demand for catalysts is driven by increasing population growth, which in turn means more people using liquid fuels, refiners processing heavier feedstocks, and refiners' need to increase productivity to offset high energy and raw materials costs.

To get an idea of the demand for refining catalysts, consider the anticipated growth in liquid fuels consumption; according to the Energy Information Association, world liquid fuel consumption will increase from 84 million barrels per day in 2005, to 113 million barrels per day in 2030, with transportation fuels accounting for 75 percent of the projected growth. To meet this demand, multi-national oil companies are expanding production, and more refining capacity equates to increased catalysts consumption. One example, Sinopec started production this year of a 10 million-ton-per-year, or about 214,280 barrels per day, refinery in Qingdao City, China.

The escalating cost of light crude oil has caused refiners to look for less expensive alternatives, such as heavy crude oil and tar sands. This shift in refiners' raw material consumption toward heavier feedstocks requires more FCC and hydrotreating catalysts, as well as new catalysts technologies that

can stand up to the high concentration of contaminants found in these heavy materials. This is compounded by the trend toward lower sulfur and nitrogen levels to meet specifications of gasoline and diesel. Processing heavier and dirtier feedstocks adds pressure on both ends of the FCC unit. First, refiners are forced to do upfront hydroprocessing (FCC feed pre-treating) of the incoming feedstock before it gets to the FCC unit. And, because of tightening sulfur requirements, extra hydroprocessing (more catalysts or more sophisticated catalysts) are required to reduce the sulfur level of diesel and gasoline down into the ppm level. In addition to sulfur reductions, refiners will face tightening regulations on benzene in gasoline starting in 2011.

Market needs are also changing, which will require changes in the distribution of refined products. While the traditional product distribution from an FCC unit was comprised mostly of gasoline, with only a small amount of propylene and diesel, this is changing. For instance, there is a trend to produce more light olefins to meet the demand for downstream derivatives, primarily polypropylene.[To increase propylene yield, refiners must run their FCC units at more severe operating conditions and use more FCC catalysts and additives.

1.1.2 Emerging Areas for Growth

The historically high crude oil price (~$70/barrel at the writing of this report) is ushering in new opportunities for catalysts producers in the refining and petchem industries. First, producers are looking for alternative raw materials, i.e. less expensive feedstocks, which require new catalyst and/or more catalysts as discussed above for refiners processing heavier crude oils. For chemicals producers, which rely on crude oil to produce petchems, they are exploring other options, including the use of "underutilized" feedstocks.

One such underutilized feedstock is methane, a major component of natural gas. Natural gas is an abundant resource, yet 30 percent–60 percent of its reserves are considered stranded, meaning that they cannot be used locally and cannot be efficiently transported to market. Dow Chemical has developed a lanthanum trichloride ($LaCl_3$) catalyst that reacts methane with hydrogen chloride to form the intermediate methyl chloride, which can be converted into chemicals or fuels using well-known chemistry. Another such feedstock is carbon dioxide, which is being explored by companies, including BASF, as a raw material for valuable fuels and chemicals.

Another alternative source of raw materials is the conversion of synthesis gas. Where syngas conversion was once uneconomical, it is now able to compete with gasoline and other crude-based chemicals. Synthesis gas—a mixture of carbon monoxide (CO) and hydrogen—is produced through gasification of coal, biomass, or waste. The resulting syngas can be transformed using Fischer-Tropsch—a catalytic process that converts syngas into liquid hydrocarbons—to produce fuel products including dimethyl ether (DME), methanol, and synthetic natural gas (SNG). Methanol, in turn, can be converted to olefins, followed by the conversion of olefins to diesel.

Researchers at the University of North Carolina and Rutgers University are developing a catalyst system that takes the lightweight hydrocarbons produced by Fischer-Tropsch and boosts their molecule weight to a range that makes them viable as diesel fuel.

The growing demand for alternative fuels—biofuels, green diesel, and methanol, to name a few—to address energy security issues as well as the high price of crude oil is creating opportunity for the catalysts industry. Catalysts producers, organizations, and academia are researching a broad range of alternative fuels technologies, some of which require the use of catalysts. UOP, for example, has developed its green diesel technology, which is produced by reacting methanol and vegetable oil in the presence of several heterogeneous catalysts, each containing a metal functional group on a support. Süd-Chemie has developed copper-zinc catalysts for converting natural gas into methanol.

1.1.3 Uncertainties and Challenges

The current demand for catalysts is strong as reflected by earnings of catalysts producers. However, there are some uncertainties and challenges that the industry will face. First, the weakening global economy could alter capital investment in new refining capacity and the construction of new facilities, in particular gas-to-liquids plants, which require a large upfront investment. If the credit market remains as it is, it will be difficult for companies to obtain loans for these investments; this could either delay projects or stop them indefinitely.

Another challenge that continues to face catalysts producers is the rising cost of metals and energy. While this high cost of energy brings opportunities to the catalysts industry (discussed above) it also has a negative effect in that it costs more to produce the catalysts. So far, catalysts firms say they've been able to pass-through most of the cost increases. However, if conditions worsen, this could be a concern.

1.2 Goal and Scope of this Report

This report analyzes and forecasts the prospects for catalysts used in refining and petchem production in the coming eight years. In the report, we review the range of materials currently utilized or under development for catalysts, including interesting research underway in universities and industrial labs. We also investigate how the catalysts materials markets are changing, including the impact of shifts in refining and chemicals production feedstocks, and the increasing demand for syngas conversion and alternative fuels production.

We provide an in-depth review of current R&D, as well commercialization efforts by catalysts producers. In addition, the report contains detailed forecasts of major catalysts application categories, in both revenues and volume terms.

This report is entirely international in scope. The forecasts are worldwide forecasts and we have not been geographically selective in the firms that we have covered in the report or interviewed in order to collect information.

1.3 Methodology of this Report

This report is based on extensive interviews with the key, as well as emerging, players throughout the catalysts community, as well as extensive secondary research including an analysis of relevant applications markets. To determine where the opportunities are, we have based this report on both primary and secondary research. The secondary research drew on the World Wide Web, commercial databases, trade press articles, SEC filings and other corporate literature to fill out what is going on in this sector. The forecasting approach taken in this report is explained in more detail in Chapter Four.

1.4 Plan of This Report

Chapter Two of this report reviews the types of catalysts that are being commercially used and developed for the refining industry and In Chapter Three, we analyze the catalysts materials used for syngas conversion and petchem production. For both Chapter Two and Chapter Three, we discuss the specific types of catalysts that are used and under development; the activities of the major players for each material type; and where there's room for improvement, i.e. opportunities for materials firms. In Chapter Four, we provide detailed eight-year forecasts of catalysts materials across the entire refining process and petchem production.