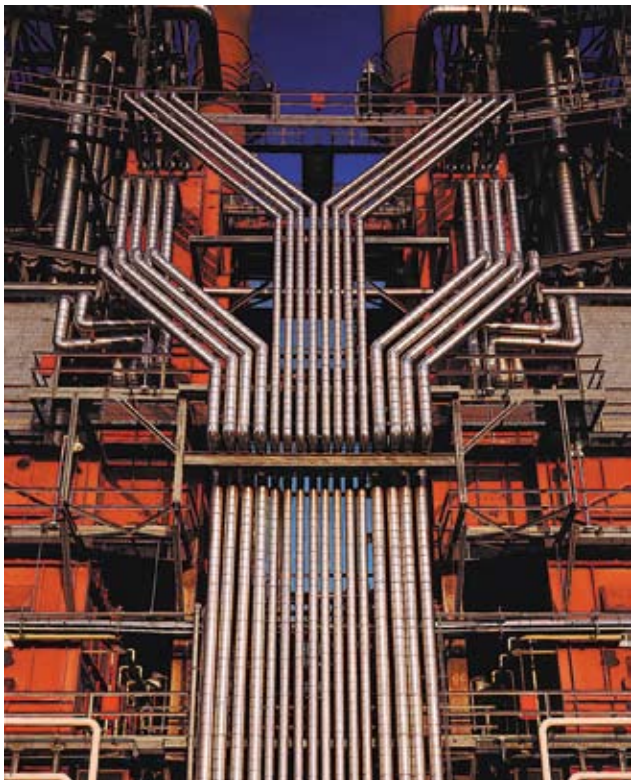
Quality products from

Chevron Phillips Chemical Company LP

The Woodlands, Texas

E-SERIES CATALYST

FOR SELECTIVE ACETYLENE HYDROGENATION IN ETHYLENE PLANTS



CHEVRON PHILLIPS CHEMICAL COMPANY LP

As a major ethylene producer, Chevron Phillips Chemical Company LP (Chevron Phillips), a joint venture of Chevron Corporation and ConocoPhillips, has conducted extensive research and development to improve ethylene cracker operations. One of the results of these efforts had been the commercialization of new selective acetylene hydrogenation catalysts known as E-Series catalyst.

Unparalleled Expertise

Chevron Phillips has been a commercial producer of ethylene since the 1950s with six ethylene crackers and several others planned or already under construction. Chevron Phillips operates more than 30 manufacturing facilities in eight countries and has seven research and technology centers.

Chevron Phillips' success with the E-Series catalyst goes far beyond its own acetylene converters. Chevron Phillips has the ability to custom formulate catalysts based on customer needs and process design, to offer catalysts with higher selectivity, improved stable operations without runaways, longer cycle run lengths and longer overall catalyst life. The fact that Chevron Phillips is both an ethylene producer and catalyst supplier is a great benefit to our customers since we have personal insight into reactor operations.

Types of Ethylene Plants

Ethylene crackers can be broadly divided into two basic configurations, those with front-end acetylene converters and those with back-end converters. Front-end acetylene conversion involves the hydrogenation of acetylene prior to the removal of methane and lighter components from the cracked gas stream (at the front of an ethylene plant) while in back-end plants, the acetylene conversions occurs in a stream at the back end of the plant where basically only ethane, ethylene, acetylene and possibly some carbon monoxide enters the acetylene converter. The differences in feed compositions require different catalyst formulations in order to provide optimum and stable performance.

Chevron Phillips markets several formulations under the E-Series catalysts designation by acetylene converter type:

FE E-DC2 (for front-end deethanizer converters)

FE E-DC3 (for front-end depropanizer converters)

FE E-RG (for front-end raw gas converters)

BE E (for back-end converters)

FE E-DC2 (Front-end deethanzier)

Front-end deethanizer reactor feed is relatively clean, containing minimal sulfur and metal contaminants. The reactor feed in this configuration lacks methyl acetylene and propadiene (MAPD), and many new plants contain a relatively low concentration of carbon monoxide (CO) of below 200 ppm and sometimes even below 50 ppm. Without the MAPD and CO to otherwise moderate the reaction in the acetylene converter, runaway reactions can occur with non-selective catalysts. This is why the high selectivity of E-Series catalyst is so important in the front-end deethanzier configuration.

E-Series catalyst has been specially formulated to provide the highest selectivity to ethylene possible which translates into thermal stability, whether in steady state operation or during changes CO levels or flow rates. In addition, the E-Series catalyst deethanzier formulation has numerous commercial references with over 10 years of continuous operation without requiring regeneration. This provides a substantial economic benefit to the E-Series catalyst customers.

FE E-DC3 (front-end depropanizer)

The front-end depropanizer feeds are more likely to contain sulfur, butadiene and metal contaminants that can cause catalyst deactivation. The MAPD and CO concentrations are present in higher concentrations than in deethanizer feed so while reactor thermal stability is less of a concern, FE E-DC3 catalyst has been tailored to provide high activity and tolerance to contaminants, while at the same time maintaining excellent selectivity to ethylene. Other commercial catalysts offer high activity but sacrifice selectivity. This superior selectivity enables E-Series catalyst formulations to also provide much longer acetylene converter run lengths compared to other catalysts.

FE E-RG (raw gas)

Raw gas feeds contain higher levels of butadiene and heavier components which can be as reactive as acetylene in hydrogenation reactions. Raw gas reactors are known for higher temperature rises across the converter and thus have poor reactor stability and selectivity if an inappropriate catalyst is used. The FE E-RG formulation was custom tailored to provide high selectivity in the "high delta T" environment. The commercial operators of E-Series catalyst benefit from high selectivity and lower converter heat rise such that less reactor fouling occurs from butadiene. This enables the converter run lengths to be substantially increased compared to those using other types of acetylene hydrogenation catalysts.

BE E (back-end)

The back-end feeds are unique in that acetylene, ethylene, and ethane are the major components without the excess of hydrogen as in the front-end configurations. Hydrogen is metered in limited amounts into the reactor to react with acetylene. Operating the reactor under these conditions permits reasonable selectivity to ethylene and minimizes the risk of temperature excursions.

However, without excessive amounts of hydrogen, a significant amount of acetylene may be oligomerized to "green oil." This green oil production is a major concern with back-end converters because the resulting fouling of the catalyst shortens the converter run length. Frequent regenerations are required to restore catalyst activity. Typically back-end converters display a steady state decline of catalyst activity and selectivity with on stream time as the green oil fouls the surface of the catalyst.

While the Chevron Phillips back-end catalyst formulation has not totally eliminated the formation of green oil, the formation quantity is less. The color of this oil is transparent, has a lower viscosity and a lower molecular weight as compared to green oil produced from other commercial catalysts. Therefore, Chevron Phillips' back-end formulation is less susceptible to fouling, maintains higher selectivity throughout the run and a slower rate of temperature increase. All of the factors lead to longer cycle run lengths and increased profitability.

Benefits

The high selectivity and stability of E-Series catalyst allow the operator to meet extremely low acetylene levels in the reactor effluent while reducing acetylene converter down-time and off-spec production without sacrificing production stability.

Excellent Selectivity – E-Series catalyst quantitatively removes acetylene while limiting the amount of over-hydrogenation of ethylene to ethane. This enhanced selectivity results in an increased amount of ethylene production as well as in the reduction of reprocessing cost of the recycle ethane.

Stable ARU Operations – E-Series catalysts are much more stable when operating at the higher conversions necessary to lower the acetylene to tighter ethylene specifications. Operation of other catalysts at this conversion level can result in temperature excursions that can lead to dangerous temperature "runaway" conditions.

Resistance to CO Changes – Reactors operated with E-Series catalyst are highly resistant to temperature excursions due to fluctuations in carbon monoxide content in the feed. Changes in carbon monoxide levels with traditional catalysts can often lead to off-spec production and temperature runaway conditions. For example, following the decoking of a furnace, an operator can easily adjust the temperature of the acetylene reactor containing E-Series catalyst to accommodate changes in the carbon monoxide content of the feed. This allows the reactor to be operated with little or no off-spec production.

Ease of Reactor Startup – Using E-Series catalyst enables a quicker startup while minimizing off-spec production compared to traditional catalysts.

Ease of Use – E-Series catalysts can easily be regenerated by either ex- or in-situ methods. The high crush strength of the catalyst enables them to maintain their integrity through multiple handlings.

Customer Service and Support

As a worldwide manufacturer and marketer of specialty chemicals, Chevron Phillips maintains an experienced staff ready to assist with various order processing and shipping alternatives. Our group of knowledgeable chemists and engineers is also ready to assist customers with technical service issues. With significant experience as a major ethylene producer, Chevron Phillips is uniquely qualified to understand the customer's catalyst and processing needs. Laboratory experimentation, pilot plant operations, and advanced modeling techniques are also available to address customer inquiries. Our support extends to our experienced professionals assisting with operator training, plant startups, and acetylene converter kinetic and thermodynamic modeling general troubleshooting.

Research and Development

Chevron Phillips is continuing with focused research and development to improve the applications of our selective hydrogenation technology. Our core expertise in catalyst development is supported by an exceptionally broad range of equipment capabilities to optimize catalyst performance. Our manufacturing expertise is supported by a wide range of analytical and pilot plant scale testing activities.

More Information

Additional information concerning E-Series catalyst, such as physical property data and safety and handling guidelines, is available. You can count on Chevron Phillips to provide excellent quality control, customer service, technical expertise, and responsiveness to your needs. For additional information, please contact the sales office nearest you, or visit our website at www.cpchem.com.

Technical Data Sheets and Material Safety Data Sheets are available upon request.

E-mail us with your questions about our products at specialtychem@cpchem.com.

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