Converting low-value feed to high-value products – CLG Hydroprocessing technologies and catalysts

CLG

Chevron Lummus Global

Technology Innovations Introduced Through The Years

2005	Single-Stage Reaction-Sequencing (SSRS)	Commercialized full-conversion ISOCRACKING with sequenced reactors that lowers energy and investment costs.
2003	ISOMIX® Internals	Reactor internals integrating advanced mixing and redistribution technology that produces very low radial spreads, high catalyst utilization and improved unit operating safety.
1998	Optimized Partial Conversion ISOCRACKING (OPC)	Revamp alternative that produces high conversion to very high-quality products at less investment than conventional methods through the addition of a small reactor.
1997	Split-Feed Injection	Commercialized split-feed configuration that integrates distillate ISOTREATING with ISOCRACKING, significantly lowering investment costs.
1996	Upflow Reactor (UFR)	Upflow reactor, without onstream catalyst replacement, that enables refiners to very economically increase capacity of their downstream unit without significantly increasing reactor pressure drop.
1994	Nautilus Internals	Innovative reactor internals that enhance liquid/liquid and gas/liquid mixing to provide excellent radial temperature distribution in the reactor with low pressure drop.
1993	ISODEWAXING	Catalytically isomerizes the molecular structure of the wax into isoparaffins producing base oils with properties similar to synthetic base stocks.
1992	Onstream Catalyst Replacement (OCR)	Countercurrent moving-bed technology that replaces catalyst onstream. OCR removes metals from feeds for downstream reactors enabling them to process heavier feeds and/or achieve deeper desulfurization.
1978	LC-FINING	Residuum hydrocracking technology that economically achieves higher conversion to light products from difficult feeds.
1977	VRDS Hydrotreating	Only technology capable of upgrading vacuum residuum from sour and heavy crudes into ultra-low sulfur fuel oil.
1969	VGO Hydrotreating	Removes contaminants such as sulfur, nitrogen, condensed ring aromatics and metals from VGO to produce environmentally acceptable clean fuels.
1966	RDS Hydrotreating	Residuum hydrotreating technology first introduced to produce low sulfur fuels from high sulfur atmospheric residuum. Today, it is the most economic alternative for pre-treating RFCC feed.
1959	ISOCRACKING	The world's first hydroprocessing technology available for upgrading difficult feeds into high-value transportation fuels. This flexible technology was rapidly introduced using a variety of flow schemes, including single stage (with and without liquid recycle) and two stage, to optimize performance for refiners.

CLG

Helping Refiners Find the Right Processing Schemes for Cleaner Products

The toughest challenge facing refiners today is how to optimize the production of cleaner products from a broad range of feeds. We speak from experience. We have designed thousands of projects in 70+ countries.

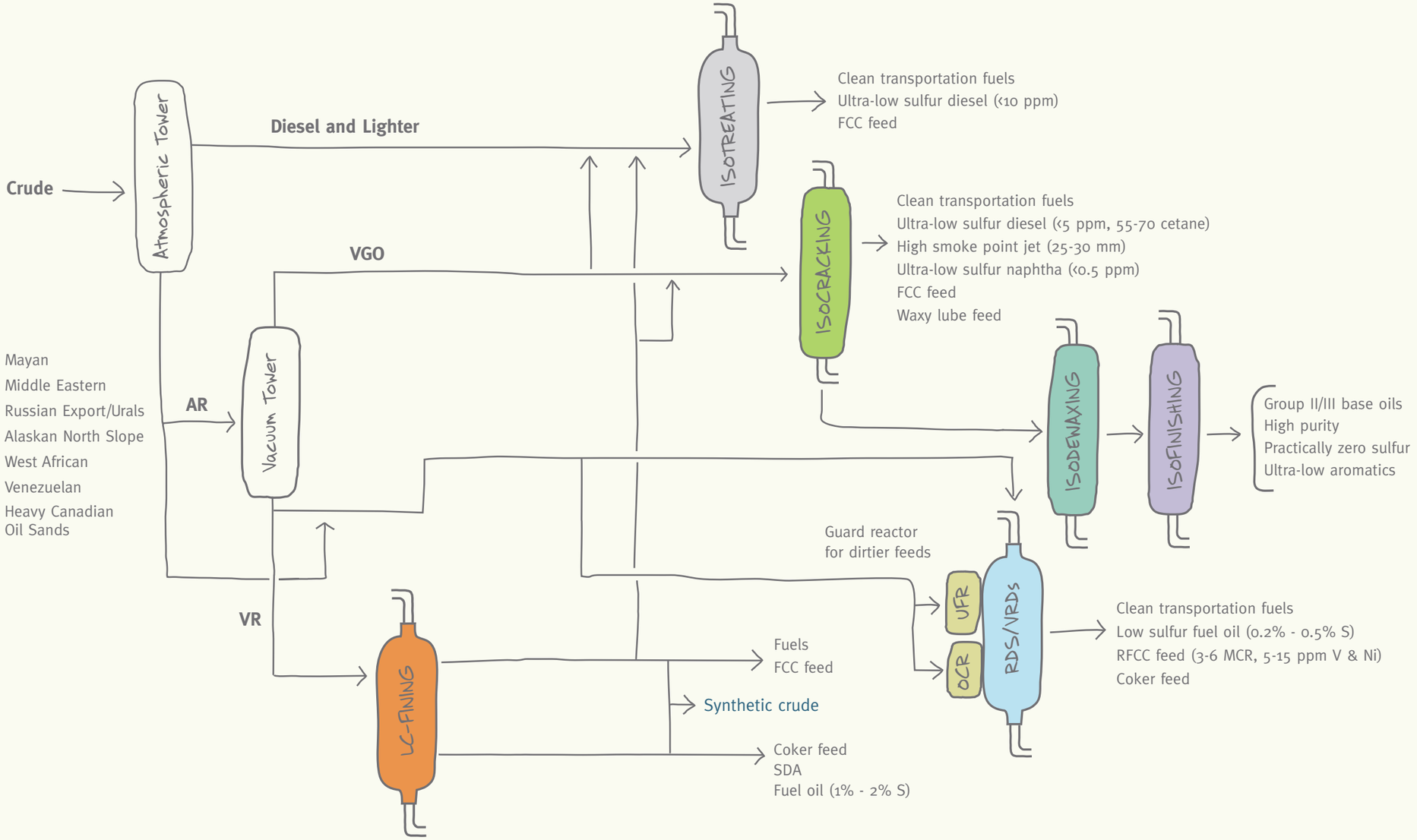
Refiners choose our technologies because they deliver higher conversion to lighter products and have fewer operating problems, regardless of feed quality. Why? Because every project is tailored for optimizing the refiner's desired product slate from a given feedstock. Plus, from day one, every project is supported by a diverse technical team largely comprised of people who have decades of hands-on, day-to-day operating experience in refineries around the world.

We have designed thousands of projects in 70+ countries. More than half of the world's hydroprocessing capacity uses CLG technologies.

CLG Technologies

Designed for optimizing production of the cleanest products from all types of feeds

Chevron, a leading refiner and innovator of hydroprocessing technologies, combined resources with Lummus Technology, a leading technology and engineering company, and formed Chevron Lummus Global (CLG). CLG has a depth of experience in designing, building and operating hydroprocessing units unmatched in the industry. Today, we offer a full suite of technologies and catalysts designed for optimizing production of the cleanest products from all types of feeds.



PROFIT

Bottom-of-the barrel? Convert it to a profit center.

Over the last decade, nearly 80%

of all refiners chose CLG's residuum hydroprocessing technologies to convert difficult feeds to clean, low sulfur products.

In every project, CLG assesses the objectives and tailors the technologies and catalysts to fit the unique processing requirements of converting a given crude source into the desired product slate.

CLG offers a family of residuum conversion technologies and catalysts that can be tailored to help refiners optimize product quality, product yield, run length, capital investment and operating costs:

- **LC-FINING** is well-suited for hydrocracking extra-heavy residuum, bitumen and vacuum residuum feedstocks into low sulfur products.
- **RDS** removes sulfur, nitrogen and metals from residuum, producing clean RFCC feedstocks for conversion into clean fuels and base oils.
- **UFR and OCR** guard-bed technologies enable refiners to increase feed throughput and/or process heavier feeds with higher levels of contaminant metals while maintaining excellent product qualities.

LC-FINING

Ebullating Bed Process

Efficiently hydrocracks extra-heavy residuum, bitumen and vacuum residuum feedstocks to high-quality transportation fuels and fuel oils

CLG's ebullating bed process, LC-FINING, provides high distillate product yields while concurrently removing metals, sulfur, Conradson Carbon Residuum (CCR) and asphaltenes from difficult feedstocks. Only CLG's LC-FINING process reduces both capital investment and operating expenses when upgrading to produce cleaner products from difficult feeds. Its integrated onstream catalyst addition and withdrawal system eliminates the need to shut down for catalyst replacements. The catalyst, and its addition rate, are customized for optimally converting the refinery's crude source into the desired product slate.

The proprietary hydrogen recovery system is tailored to be either low or high pressure depending upon the refinery's economics. The low-pressure recovery system eliminates most of the high-pressure equipment required downstream of the reactors in other processes, while the high-pressure recovery system reduces power consumption by 0.25 hp/bbl. In every project, equipment pricing versus utility savings is evaluated so that production of the desired product slate is optimized. When LC-FINING is integrated with coking and deasphalting, distillate liquid yields as high as 92% can be achieved.

- **Mayan**
- **Middle Eastern**
- **Russian Export/ Urals**
- **Venezuelan**
- **Heavy Canadian Oil Sands**

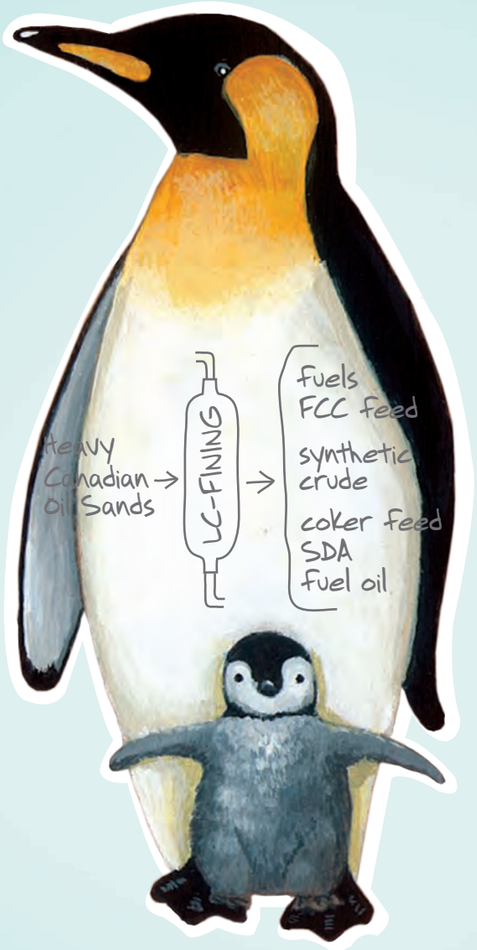
LC-FINING hydrocracks the most difficult feeds.

Shell Canada generates higher revenue at its Scotford upgrader with CLG's LC-FINING technology.

CLG's LC-FINING process efficiently hydrocracks residuum and other low-quality feeds producing upgraded fuel oil and transportation fuels. It also triples the value of bitumen from oil sands by producing high-quality synthetic crude oil.

Advantages of LC-FINING:

- Ability to handle most difficult feeds with metals content up to 600 ppm
- Higher conversion of residuum to lighter distillates
- Can be integrated with hydrotreating and hydrocracking on same processing platform
- Higher reliability
- Can run continuously for 4 years
- Lower catalyst consumption
- Lower operating costs



The adult Emperor Penguin stands up to 48 in. (122 cm) tall and can weigh from 50-100 lbs (22-45 kg). Highly adapted to their harsh Antarctic environment, penguins have the highest feather density of any bird, can drink saltwater, and dive to depths of 1,500-1,600 ft (450-500 m) without risk of barotrauma or decompression sickness. With no land predators, penguins have no fear of humans and will approach to within 10 ft (3 m) without hesitation.

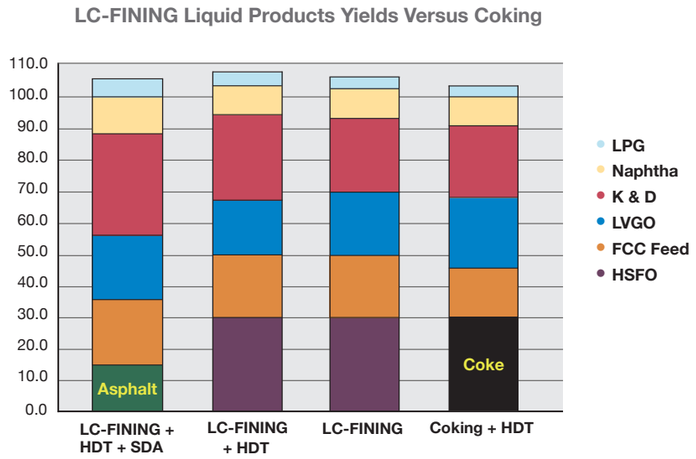
How LC-FINING Works

The LC-FINING ebullating-bed process efficiently converts petroleum bottoms and other heavy hydrocarbons into high-quality fuel oils, or prepares them for more efficient conversion into ultra-low sulfur distillate products.

Feed from extra-heavy residuum, deasphalted oil or bitumen from oil sands is mixed with hydrogen and reacted with catalyst in an ebullating bed reactor. The back mixing in the ebullated bed reactor produces an efficient isothermal operation, eliminating the need for quenches within the reactor. Product quality is maintained at a consistently high level because fresh catalyst is intermittently added and spent catalyst removed while the reactor is onstream.

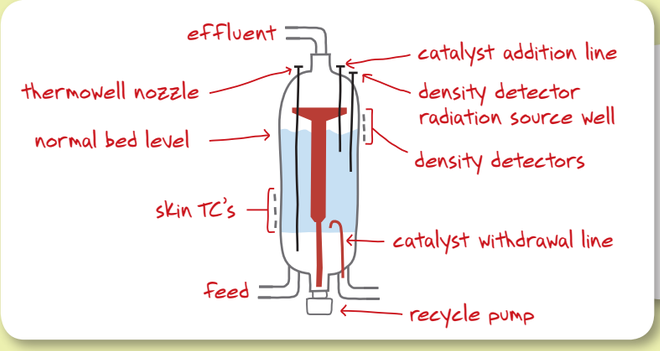
Reactor products flow to the high-pressure separator, low-pressure separator and then to product fractionation. Recycled hydrogen is separated and purified. Depending on refinery economics, the commercially proven low-pressure hydrogen recovery system can be utilized for purification of the recycle gas, which requires lower capital investment and allows design at lower gas rates.

Residuum product from the LC-FINING process can be used as fuel oil, synthetic crude or as feedstock to a coker or a solvent deasphalter. With conversion rates of 80% and higher, LC-FINING delivers high yields and high removal of contaminants in a safe, reliable, easy-to-operate plant at low investment.



Residuum conversion volumetric yields with typical ME crudes

LC-FINING process configurations provide higher liquid product yields versus coking.



LC-FINING maximizes sulfur and metals removal.	
565°C Conversion Range	60 - 80
% HDM	85
% HDS	85

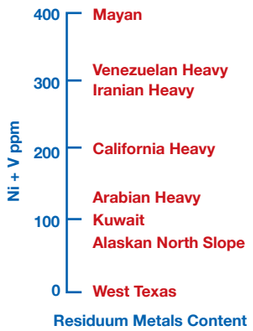
Ultra-Low Sulfur Diesel and Gas Oil from the LC-FINING Process

LC-FINING technology can be easily integrated with distillate hydrotreating or hydrocracking processes to produce high-quality middle distillate products. Unlike coking, clean products can be produced without building an additional plant. By eliminating the need for additional downstream processing, refiners who choose LC-FINING have a more economical upgrade path for meeting the global demand for cleaner fuels. With more than 350,000 BPSD of difficult feed being converted to clean product using LC-FINING technology, its reliability is being proven day after day.

LC-FINING Configuration Options	Characterization
Single Reactor LC-FINING / ISOFINING	• Capable of producing synthetic crude or coker feed • Low to moderate residuum conversion • High LHSV, low-cost option • Efficient heavy-crude upgrading
Multi-Reactor LC-FINING	• Two or three stage reactors in series • Capable of producing LSFO or coker feed • Moderate to high conversion and heteroatom removal
Multi-Reactor LC-FINING with Integrated Hydroprocessing of Converted LC-FINING Feed	• High conversion with excellent product qualities • Efficient use of high-pressure circuit • Integrated hydrotreater or hydrocracker produces ultra-low sulfur diesel or VGO
Combination of LC-FINING with Deasphalting	• Deasphalting either upstream or downstream of LC-FINING unit • Maximizes distillate production • Pitch can be pelletized or processed further in a coker or POX unit

RDS/VRDS

Fixed-Bed Residuum Hydrotreating



Fixed-bed residuum hydrotreating units can readily process feedstocks containing as much as 150 ppm metals (Ni + V). Adding a UFR or OCR guard-bed reactor enables refiners to process feeds with as high as 400 ppm metals (Ni + V).

RDS & VRDS technologies have successfully improved the efficiency of every type of RFCC unit in operation today.

Pre-treats residuum from heavy crudes for ultra-low sulfur fuel oil production and for RFCC conversion into high-quality, ultra-low sulfur transportation fuels

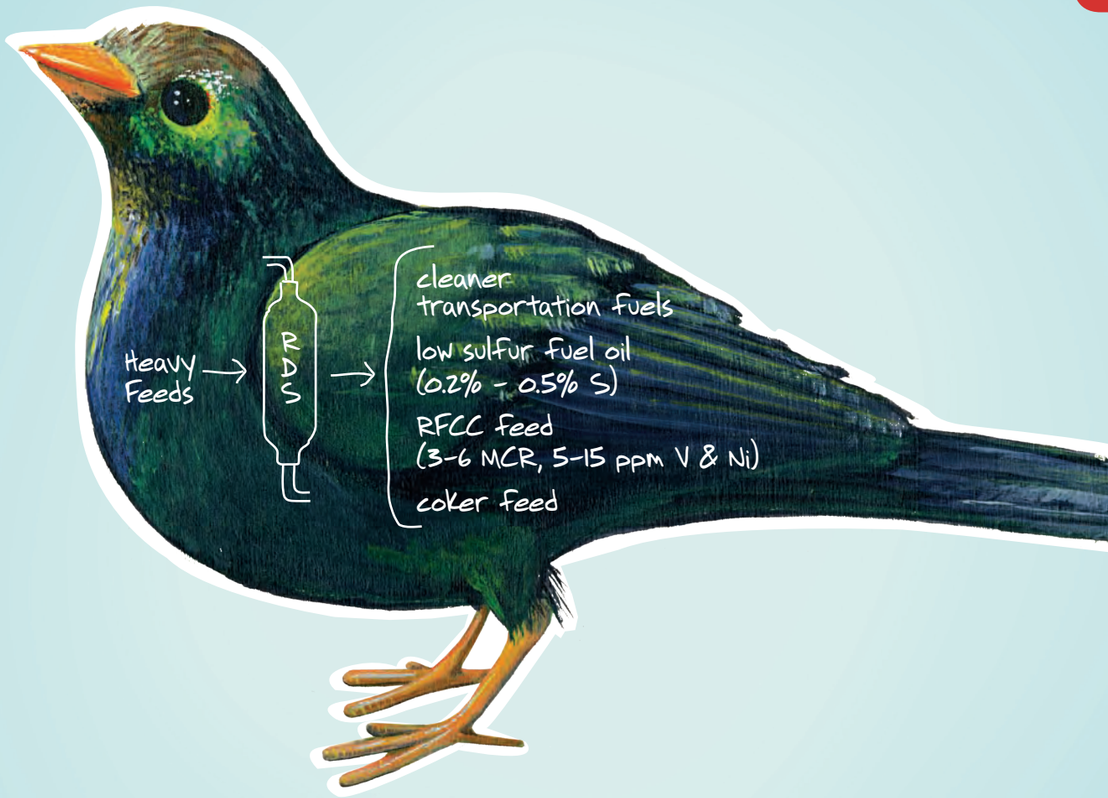
CLG's fixed-bed residuum hydrotreating technologies, RDS for atmospheric residuum hydrotreating and VRDS for vacuum residuum desulfurization, provide a short, economical processing path for producing higher-value products from difficult feeds. Residuum Fluid Catalytic Cracking (RFCC) is the most popular processing route for the complete conversion of residuum oils. Without a pre-treating system in place, refiners must process atmospheric residuum from expensive crudes that are low in metals, carbon residuum and sulfur to avoid operating problems. Pre-treating RFCC feed with CLG's hydrogen-efficient RDS/VRDS technologies sufficiently saturates even the most difficult feeds so that no further processing is necessary to produce high-value, light products.

CLG invented the technology in 1966. In the last 20 years, 90% of all fixed-bed residuum units have been licensed by CLG. Detailed operating data on feed and processing results have been collected and analyzed. With that information the reactor internals and catalyst systems have been continually refined and upgraded so that every unit is optimized for product quality, yield, run length, capital investment and operating costs.

Customized catalyst and superior internals extend operating cycles

After completing a thorough analysis of feed characteristics relative to operating kinetics and chemical reaction, CLG tailors the catalyst system for optimal performance. Every catalyst system is unique to the refiner's particular need. As a result of a robust catalyst grading system and ISOMIX® internals, 12 months or longer cycle lengths are achieved while meeting targeted specifications for demetallization, desulfurization, carbon residuum reduction, denitrification and increased cracking conversion.

With a CLG RDS/VRDS residuum hydrotreating unit in the processing scheme, refiners have more flexibility in feed selection, achieve higher product yields and have fewer feed-related operating problems.



Birds evolved from theropod dinosaurs approximately 150–200 million years ago. Today, there are nearly 10,000 living species. Among the most intelligent animal species, birds have been observed manufacturing and using tools as well as forming fishing associations with dolphins and tuna, which push shoaling fish towards the surface.

UFR/OCR

Guard-Bed Technologies Economically Increase Capacity from RDS Units

UFR

CLG's Upflow Reactor (UFR) process technology uses an upflow guard-bed reactor that is added to the processing scheme before the fixed-bed RDS reactors. It enables refiners to increase capacity, process heavier feeds or improve product quality from a fixed-bed RDS unit.

With a UFR in the processing scheme, refiners can increase feed throughput and/or process heavier feeds that have higher levels of contaminant metals while maintaining excellent product qualities. The UFR has lower pressure drop across the reactor than when a traditional down-flow, fixed-bed guard reactor is used. Consequently, capacity of the system can be increased by as much as 50%.

The principle advantages of the UFR are:

- Low pressure drop
- Prevention of guard-bed plugging problems thanks to the slightly expanded catalyst bed
- In case of RDS retrofits, no need to change out recycle gas compressors
- Opportunity to increase capacity as much as 50% in limited plot space
- Ability to add catalyst transfer system later
- Longer life of downstream fixed-bed catalyst

Plus, it provides refiners with the greatest flexibility if they want to process heavier feeds at a later date.

KNPC chose CLG's UFR/RDS for the world's largest residuum hydrotreater complex.

KNPC designed its New Refinery Project to help improve the state's environment while meeting the growing domestic need for power generation. To meet these objectives, they chose CLG's UFR and RDS technologies to economically produce 250,000 BPSD of low-polluting, low sulfur fuel oil from Kuwait's heavy crude.

OCR

CLG's Onstream Catalyst Replacement (OCR) process technology employs a countercurrent, moving-bed reactor. Like UFR, it enables refiners to significantly increase capacity or improve product quality from a fixed-bed RDS unit where a small fraction of spent OCR® catalyst is withdrawn and replaced with fresh OCR® catalyst on a weekly basis. When adding an OCR reactor in front of the RDS unit, refiners can increase feed throughput and/or process heavier feeds with higher levels of contaminant metals, while maintaining excellent product qualities and long fixed-bed run lengths. OCR enables refiners to process residuums with up to 400 ppm metals (Ni + V) or to achieve deeper desulfurization when processing low-metal feeds. In either case, the life of the downstream catalyst is improved substantially and problems from pressure drop buildup are reduced.

Upflow Versus Downflow Reactors

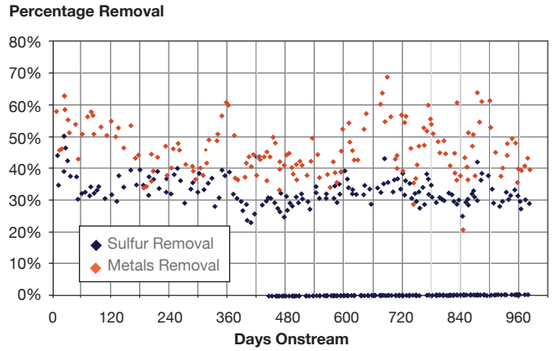
With a UFR, refiners can process heavier feeds and/or earn higher margins.

Feature	Upflow	Downflow
Catalyst bed condition	Slight expansion	Fixed
Catalyst contacting and wetting	Submerged in oil, very uniform	May not be uniform
Flow distribution	Good	Worse toward EOR
Conditions for good flow distribution	Low gas rate	High liquid and gas rate
Pressure drop	Very low	Moderate and increasing
Plugging potential	Low	Minimized with grading
Catalyst agglomeration	Less likely	Increasing with feed contaminants

From Heavy Feeds to High-Value Products Takes Just the Right Catalyst

Converting heavy feeds into high-value light products is a challenge for any processing scheme. CLG's residuum technologies outperform the competition because the catalyst system is designed to maximize the refiner's operating objectives. Working with Advanced Refining Technologies (ART), the catalyst joint venture of Chevron and Grace, CLG brings a level of processing customization knowledge unequaled in the industry. Together, ART and CLG have invested millions of dollars in technologies and catalysts that can maximize returns from the bottom-of-the-barrel. As a result, our licensees achieve greater conversion to lighter products and have fewer feed-related operating problems while processing heavier feeds.

OCR improves fixed-bed reactor volumes, particularly with high-metals residuum feedstocks.



The OCR can maintain high demetallization and desulfurization activity for as long as 3 to 4 years.

ISOCRACKING

Processing Technology and Catalysts for Producing Clean Fuels and Ultra-Low Sulfur Diesel

CLG's hydrocracking experience began with Chevron's invention of modern hydrocracking more than 50 years ago. Since then, CLG and Chevron have spent hundreds of millions of dollars developing hydrocracking technologies and catalysts that optimize the production of cleaner fuels.

Nearly half of the world's refiners are using CLG's hydrocracking technology, ISOCRACKING, and are producing more than 2 million barrels a day of clean fuels. The lessons learned from completing more than 100 projects, with very diverse requirements, enable us to offer expertise in hydrocracking that few, if any, other companies can match. As a result, CLG licensees earn top Solomon ratings with high operating factors, unparalleled safety records and consistently reliable performance.

A clear upgrade path

Refiners today are finding that the increased demand for high-quality transportation fuels is forcing them to convert a higher percentage of crude oil to lighter products. For many, that means adding hydrocracking capacity to meet more stringent product specifications. To maintain profitability, it is essential that these quality improvements be made without sacrificing product yield.

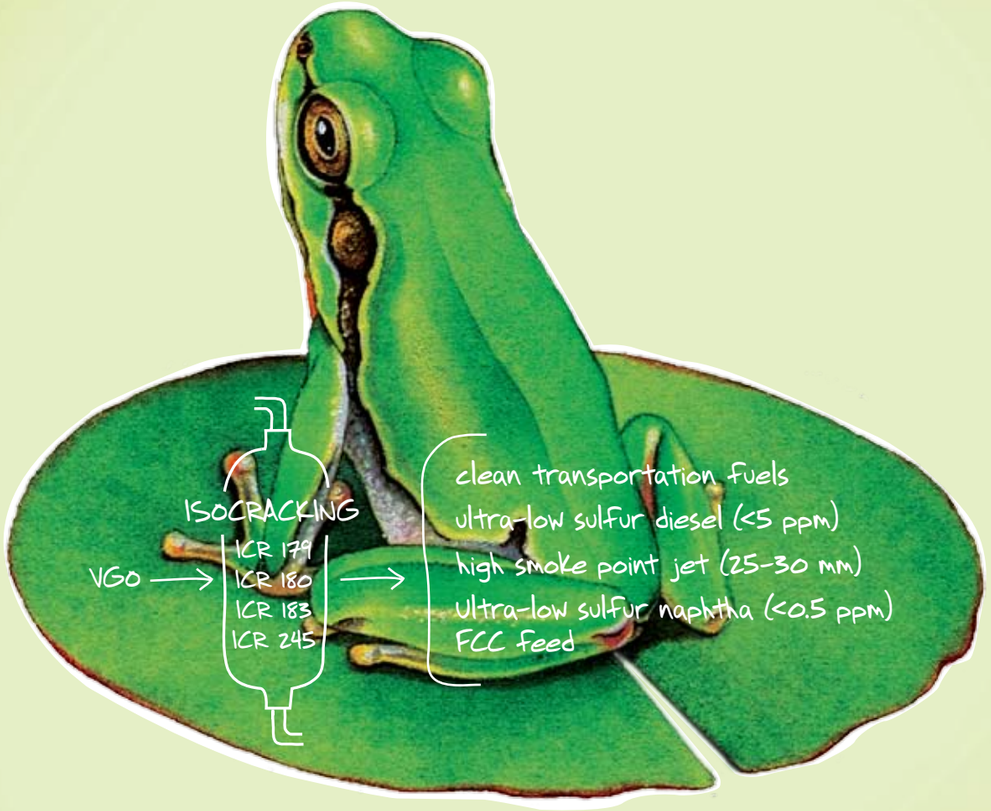
CLG's ISOCRACKING technology is the most flexible upgrade path to lighter products — a path that can help you reach a balance between stringent product specifications, product yield, cycle run length, capital investment and operating costs. CLG has helped refiners working with difficult feeds, such as heavy coker gas oils, deasphalted oils and material with a high end point (>1,000˚F) to efficiently produce clean fuels.

Around the world, the allowable limit for sulfur in transportation fuels is moving lower. In California, where CLG's headquarters are located, it went to 15 ppm in 2006. In Europe it went to 10 ppm in 2009. Through the years, CLG has repeatedly been the first to introduce technologies and catalysts that enable refiners to economically, safely and reliably meet tough new standards for cleaner transportation fuels.

Green Fuels

Diesel	**Cetane index 55-70** **Sulfur, ppm < 5**
Jet	**Smoke point, 25-30 mm**
Heavy Naphtha	**Sulfur, ppm < 0.5**

CLG ISOCRACKING produces cleaner fuels.



About 88% of amphibian species are frogs. Frogs have been critical to science for centuries. Today biochemists are studying frog toxins for use as therapeutic drugs. Chemicals isolated from frog skin produce a painkiller 200 times more potent than morphine and have shown to be HIV resistant.

CLG Customizes the Processing Scheme and Catalyst Selection So Refiners Can Maximize Profitability While Producing Clean Fuels

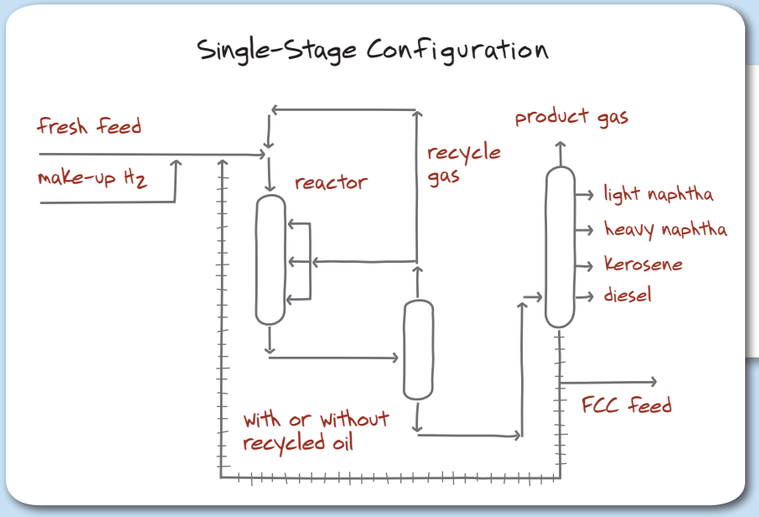
Every refiner has unique operating parameters. CLG's experienced technical team works with each licensee to design a solution that maximizes that refiner's benefit, and in the case of revamp designs, minimizes disruption to the existing refinery operations.

Single-Stage Once-Through (SSOT)

The SSOT configuration produces feedstocks with superior characteristics for FCC feeds, high-V.I. lubricant base stocks or ethylene plant feeds. It employs a moderately high-pressure design in conjunction with a tailored catalyst system that maximizes hydrodenitrification and produces high-hydrocracking activity. Because it uses only "moderate" pressure hydrocracking, the initial investment is lower. However, it provides a seamless upgrade path for economically revamping the process at a later date.

Single-Stage Recycle (SSREC)

SSREC incorporates a recycle stream and enables 100% conversion of lighter, high-quality feeds to clean products. Depending on the type of feed and desired product slate balance, SSREC can be an economical upgrade path for increasing yields of cleaner products. The SSREC is also an efficient option for processing heavy feeds in low-capacity units.



SSREC is a less expensive processing scheme for very high conversion of light feeds or low-capacity units.

It offers lower initial investment and flexibility for expansion.

Two-Stage Recycle (TSR)

CLG's TSR reactor is designed for optimizing high-capacity plants. For plant capacities exceeding 40,000 BPSD, TSR requires a smaller investment than a Single-Stage Recycle (SSREC) configuration. With TSR, refiners can process a wider range of feeds and feed rates.

Novel Configurations - Building Blocks for the Future

CLG has commercialized a series of process innovations that lower investment and operating costs, including:

- ISOCRACKING with Integrated Hydrotreating - It can save about 30% of the investment cost of a stand-alone hydrotreater.
- Optimized Partial Conversion (OPC) - It reduces the investment cost for a partial conversion unit with difficult-to-process feeds and is also ideal for revamps.
- Reverse-Stage ISOCRACKING - It allows full conversion while lowering energy and investment costs.

ISOCRACKING TSR

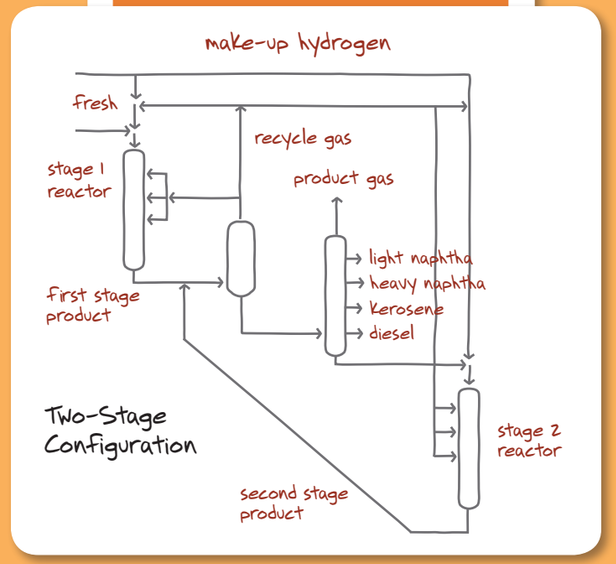
Complete conversion of gas oil to products

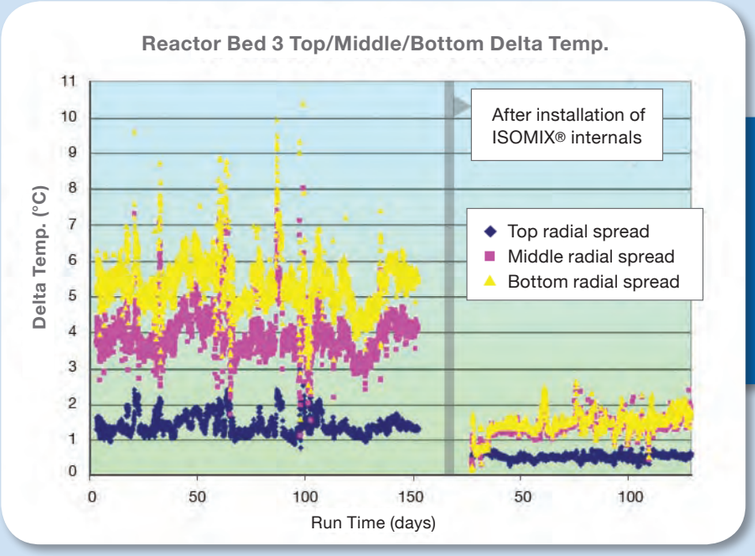
Maximized recycle cut-point flexibility

Maximized yield of middle distillates

Efficient production of very high-quality kerosene and diesel fuels

Production of heavy naphtha product that is excellent reformer feed





Reactors retrofit with ISOMIX® internals have better temperature stability with significant reduction in hot spots and temperature maldistribution. This extends catalyst life and increases yields.

ISOMIX® Inside

High-Performance Reactor Internals Provide Uniform Distribution and Prevent Hot Spots

With CLG's ISOMIX® reactor internals for fixed-bed hydroprocessing reactors, refiners can maximize catalyst utilization from high-activity catalysts and improve clean-product yields from more difficult feeds.

ISOMIX® internals consist of ISOMIX® nozzles for flow distribution and the ISOMIX® mixing box. The ISOMIX® mixing box provides thorough inter-bed mixing and quenching which prevents propagation of temperature maldistribution from bed to bed. This minimizes hot spots and provides better operating control.

The ISOMIX® flow nozzles uniformly distribute gas and liquid to the catalyst bed providing good gas-liquid mixing and heat exchange. Given the even flow, over a range of flow rates, the performance is less affected by distributor tray out-of-levelness. Plus, the spray pattern produced minimizes the catalyst depth needed for uniform and complete wetting. Consequently, there is greater catalyst utilization and higher reactor volume efficiency.

ISOMIX® internals have been used in reactors as large as 15 ft (4.6 m) in diameter and have proven to be highly safe and reliable. They take less reactor space, extend catalyst life and increase yields over other internals.

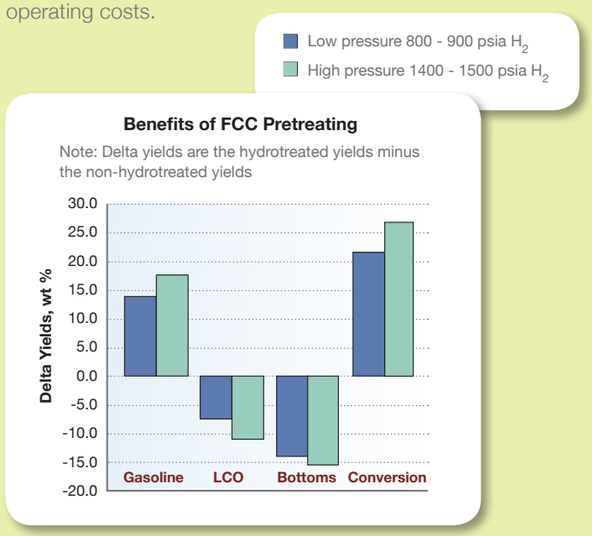
ISOTREATING

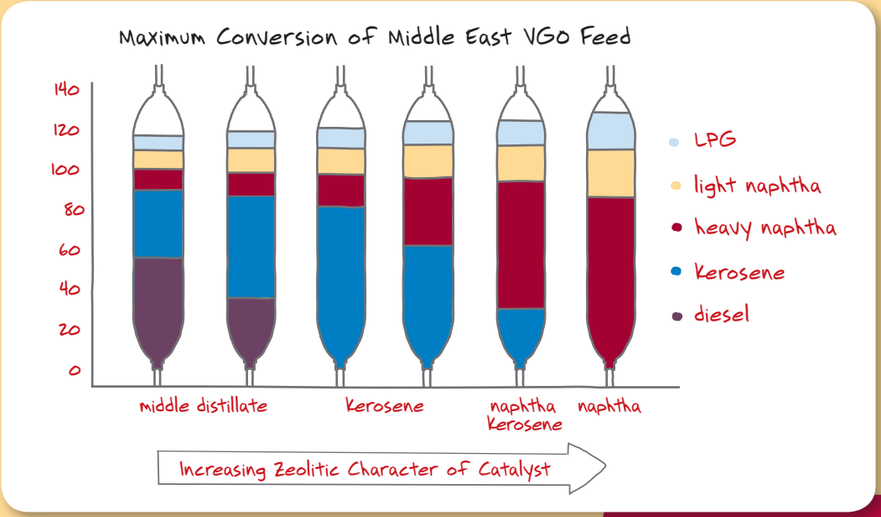
Refineries Can Convert Up to 99% of Straight-Run and Cracked Feeds to Ultra-Clean Diesel and Kerosene

The function of the ISOTREATING process is the removal of sulfur and other contaminants (such as nickel and vanadium) from the feed, and to saturate molecules, so refiners can transform more difficult feeds into higher-value products. Highly flexible, the ISOTREATING process can be added either downstream from a residuum hydroprocessing unit, such as LC-FINING, or integrated with any hydrocracking processing scheme to improve product quality and yield.

With more than 10 units in operation it has been demonstrated that integrating a reactor for ISOTREATING requires 40% lower investment to achieve a given processing objective. The reaction section requires 50% fewer pieces than that of a stand-alone unit. Additionally, when processing feed from an LC-FINING unit, the hydrotreating reactors share the same high-pressure hydrogen loop, utilizing the excess hydrogen remaining in the LC-FINING effluent. The success of the ISOTREATING process is a combination of science and experience. Every processing scheme is unique, so, based on its experience, CLG customizes the catalyst selection and layering in the reactor to optimize production of the desired product slate.
As a result, CLG has enabled refiners to upgrade heavy refractory feeds into high-value products with minimal capital expense and operating costs.

The ISOTREATING process improves the value of products from FCC feed
• Lower sulfur products (i.e., gasoline)
• Preserved octane
• Lower SO_X emissions
• Less LCO
• Better cetane
• Increased gasoline yield
• Significant increase in conversion





CLG experts tailor catalyst systems to optimize a refiner's processing objectives.

ISOCRACKING® Catalysts

Tailored Catalyst Systems

With the demand for cleaner and cleaner fuels growing rapidly, proper catalyst selection is more important than ever.

With more than 50 years of experience developing both hydrocracking catalysts and technologies, we have learned that optimizing production is best achieved by layering one or more hydrodenitrification and hydrocracking catalysts and creating a catalyst system unique to the refiner's operating environment and processing objectives. CLG designs layered (and even blended) catalyst systems because the feedstock changes chemical properties along the reaction pathway. With a layered/blended system, refiners achieve maximum conversion and throughput while meeting more stringent product quality specifications.

We start by assessing feedstock type, operating conditions, the desired product specifications, and unit operating objectives. That data is then compared to the information we have accumulated from our work with the operators of more than half of the hydrocracking units in operation today. Given the wide variety of feedstocks, processing conditions and tightening product specifications, there is seldom a perfect match, but our library of actual operating data is so large, we are able to complete analytical iterations with a high degree of confidence. CLG knows how to formulate and combine catalysts for optimum synergy between components. The end result is a catalyst system that optimizes the balance of cracking activity, hydrogenation activity, yield selectivity and catalyst life.

Ongoing Catalyst Development

The need to get more productivity, more flexibility and more profitability from the hydrocracking process is an ongoing challenge for refiners. CLG's ISOCRACKING® catalyst development team has been addressing that challenge for more than 50 years. In the 60s, the focus was on the production of transportation fuels using amorphous catalysts. In the 80s, the portfolio was expanded to zeolitic catalysts for maximizing the production of naphtha and jet fuel. Since then, the investment in R&D and pilot plant facilities has continued to grow as CLG tackles the primary challenge of today, how to process the highest quality products from the broadest range of feed, without compromising yield or operating safety.

Proven Performance from ISOCRACKING® Catalyst Systems

The effectiveness of CLG's tailored catalyst systems has been proven over and over again by improved hydrocracking performance. In general, ISOCRACKING® catalysts deliver:

- Diesel fuel with a very high cetane number and low pour point even from poor-quality feeds
- Kerosene with low freeze points and high smoke points – optimum fuel combustion characteristics
- Greater flexibility in processing a wider range of feeds from different crudes
- Higher yield of high-value product over other hydrocracking catalysts when producing middle distillate products and lube base stocks
- High onstream factor by minimizing deposit of solids on processing equipment
- Hydrogen-rich products that provide better yields and product properties when used as feed for further downstream processing such as FCC, ethylene or lube oil
- Longer catalyst life for a given processing scheme
- Predictable and stable operations

Only CLG has the technical experience, expertise and catalyst selection necessary to blend catalysts in a way that optimizes the synergy between catalysts and technology to improve yields and product qualities.

Technical Expertise with You Every Step of the Way

In addition to providing tailored catalyst solutions, CLG also provides tailored technical support. During the critical catalyst loading process, CLG provides a team of technical experts who have hands-on experience in refinery operations around the world. They help get your hydrocrackers onstream quickly, and will help keep them running at peak efficiency with comprehensive support programs that provide the technical information and assistance you need — before, during and after catalyst loading. Proper catalyst loading is critical to optimizing performance.

ISODEWAXING Technology & Catalysts

Producing Premium, Water-White Base Oils

Sixty percent of the world's premium base oil is produced using CLG's ISODEWAXING technology.

ISODEWAXING technology was commercialized at Chevron's Richmond Lube Oil Plant (RLOP) in 1993. It was a huge improvement over other catalytic dewaxing processes because it delivered unprecedented high yield and base oils with superior lubricating properties. ISODEWAXING technology quickly became the preferred upgrade path for producing high-quality Group II and Group III base oils. Today, CLG as a licensor, has more experience integrating premium base oil production, in a variety of processing schemes, than any other licensor.

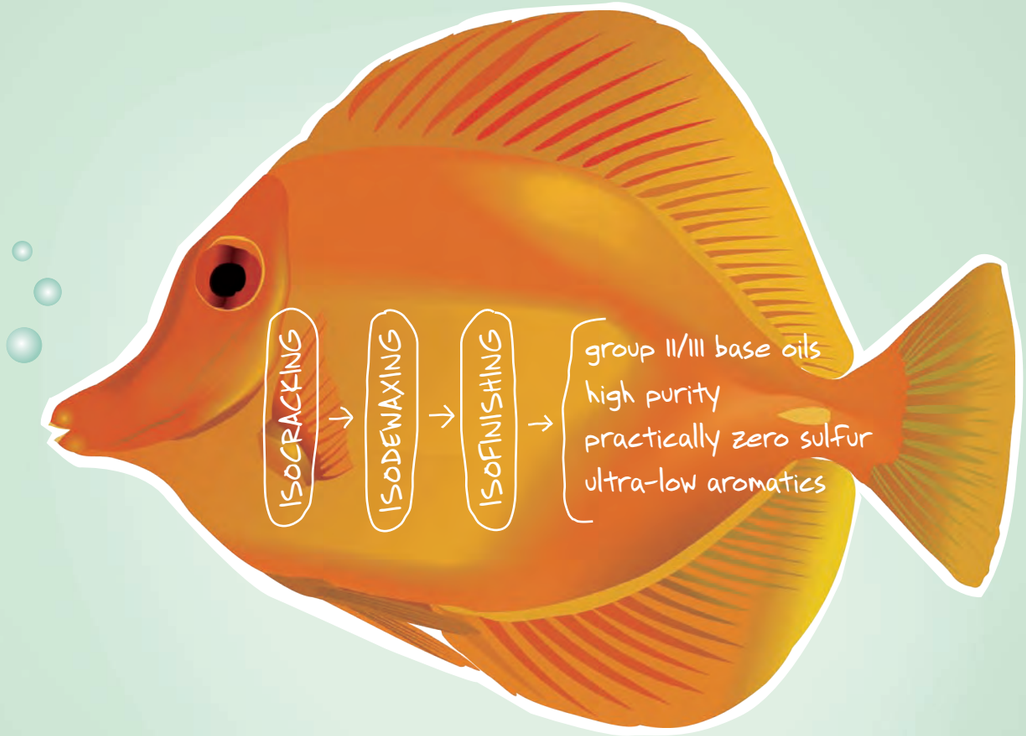
The world of base oil manufacturing was revolutionized when CLG introduced ISODEWAXING technology and catalysts in 1993. Environmental and regulatory groups were demanding cleaner-burning, more fuel-efficient engines, but engine manufacturers were constrained by insufficient capacity of high-quality lubricants that could produce the required performance.

Manufacturing vehicles with improved engine performance requires widespread availability of millions of gallons of low-volatility, low-viscosity lubricants. CLG's ISODEWAXING technology and catalysts made this possible, and, in the process, improved manufacturing operations and ROI for refiners.

High-quality lubricants require high-quality base stocks. Producing high-quality base stocks requires chemically transforming undesirable compounds in the feed. Prior to the introduction of the ISODEWAXING technology, solvent processing was used to remove the undesirable compounds. Many impurities were left in the oil. Alternatively, ISODEWAXING technology catalytically transforms waxy feed molecules into highly stable base oil molecules that can be tailored to meet the needs of almost any lubricant application.

These molecules have high V.I., low-pour points and excellent resistance to oxidation. Further, because the ISODEWAXING process preserves the base oil's paraffinicity, it can produce higher product V.I. and/or higher yields than other dewaxing processes. Today, more than 60% of the world's premium base oil is produced using CLG's technology. Those base oils are being used worldwide to produce lubricants that meet stringent performance specifications including:

- Lighter viscosity grades for increased fuel economy,
- Lower volatility for reduced oil consumption and oil thickening,
- Improved oxidation and thermal stability for longer drain intervals, and
- Improved lubricant performance at low and high temperatures to meet the needs of modern engine designs.



Fish became a successful species when it developed a hinged jaw, after which it became a dominant form of sea life and eventually branched to create land vertebrates. Scientists speculate that the hinged jaw gave fish better access to food because of greater biting force and an improved respiratory system.

CLG's Experience is Your Opportunity

CLG's technical team can help refiners optimize production of premium base oils from a broad range of feeds including vacuum gas oil (VGO); refinery process streams such as hydrocrackate or deasphalted oil (DAO), raffinates, foots oil and slack wax produced in existing solvent base oil facilities; or other waxes. Even feeds with close to 100% wax, such as slack wax, hard wax and Fischer-Tropsch derived wax, can be converted to high-value premium base oils in a once-through process without recycling unconverted wax. Using ISODEWAXING technology base oils with V.I. ranging from 95 to 140 and higher can be produced from any of these feeds. Pour points may range from low (-9 to -15°C) to ultra-low (<-40°C).

CLG's three-step, all-hydroprocessing scheme includes: ISOCRACKING technology (or ISOTREATING if processing solvent-extracted raffinates) to remove impurities, increase V.I. and improve thermal and UV stability; ISODEWAXING technology to reduce pour point; and ISOFINISHING technology to improve oxidation stability and color.

The World is Moving to All-Hydroprocessing

In response to increased capacity of high-quality base oils, automotive OEM's are rewriting performance specifications. CLG's all-hydroprocessing technology leads the way for meeting these new specifications, and is recognized worldwide for operational flexibility and superior product qualities.

Lube Yield Comparison – Hydrocracking/Dewaxing to Make 100 V.I. Base Oil

	Hydrocracker feed rate, BPD	Hydrocracker waxy base oil yield %	Dewaxer feed rate, BPD	Dewaxer yield %	Base oil yields, BPD
Catalytic dewaxing	10,000	52	5,200	81	4,200
Solvent dewaxing	10,000	63	6,300	84	5,300
ISODEWAXING	10,000	75	7,500	94	7,050

Using all-new ISODEWAXING® catalyst to make premium base oils allows the refiner to lower processing severity in the hydrocracker and substantially increase yields.

EXPERIENCE THE DIFFERENCE

CLG is the only licensor of hydroprocessing technologies that is experienced as both a refiner and world-class engineering company. Most of our staff have had hands-on operating experience with Chevron, one of the largest refiners in the United States. Our expertise extends to every phase of high-pressure hydroprocessing and we make it available to you through individualized service and a worldwide technical support network that is second to none.

When you choose CLG as your technology licensor, you gain access to a breadth of experience that started with the invention of modern hydroprocessing and expanded to include upgrading most of the world's hydroprocessing-based refineries so they could optimize the production of cleaner products.

From day one, CLG provides an experienced team of research, development and process engineers offering technical information and assistance including:

- Pilot plant studies
- Design follow-up
- Operator training
- Startup assistance
- On-site technical support
- Users' seminars
- Technology updates
- Catalyst regeneration and disposal consultation
- New product development and improvement
- Equipment evaluation
- Plant modification/optimization
- Debottlenecking assistance
- Procedures development
- Technology symposia

The result has been a worldwide network of hydroprocessing-based refineries with high operating factors, unparalleled safety records and a history of reliable performance.

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Butterflies are notable for their metamorphosis from larval caterpillar, to inactive pupal, and then into one of nature's most beautiful creatures.

CLG has spent more than 50 years developing refining technologies, catalysts and processes that enable refiners to transform the most difficult crudes into the cleanest, safest products possible. We continue to invest millions of dollars annually in research on ways to do it better. Working together we can help protect the environment around us.