REFINING TECHNOLOGIES

Customer Services

THE LEADING SUPPLIER OF **FCC CATALYST SINCE 1942**

GRACE

Catalysts Technologies

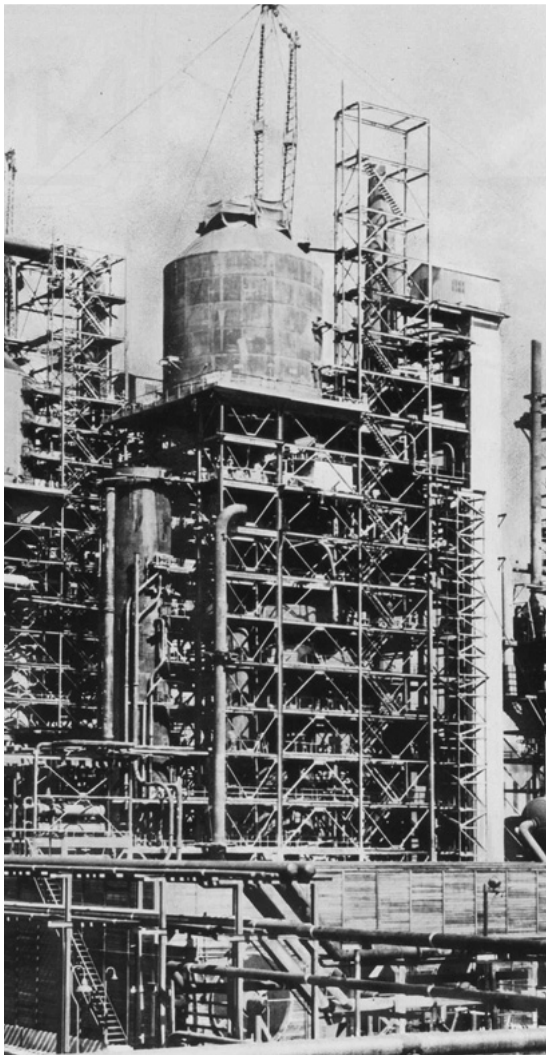
Leading Supplier of **FCC Catalysts** Since 1942

The Key to Success

The first ever FCC unit was started up on Grace catalysts in 1942.

On May 25th, 2012, the refining industry reached a milestone as it celebrated 70 years of FCC.

Grace supplied that very first catalyst, and has remained at the forefront of catalyst technology ever since.



Grace Catalysts Technologies is the global leader for FCC catalysts and additives, offering solutions-orientated approaches backed by a broad, highly differentiated portfolio and industry-leading technical service.

Grace's research leadership and flexible manufacturing system support value-added technology tailored to meet customer's current and future needs.

Grace is consistently recognised by refiners as the number one FCC catalyst supplier.

Technical Support
Industry-Leading Service

Grace technical service engineers regularly visit refineries to review unit operating data, evaluate catalyst management and unit performance, as well as provide specific recommendations to optimise unit operation.

Grace can provide expert advice on operational problems concerned with the mechanical integrity of the FCCU. For example, issues such as cyclone performance, stripper efficiencies, circulation problems, transfer line problems, slurry circuit fouling, or high unit erosion can be analysed by our technical service experts.

Grace has introduced an independent critical review service to provide a health check on FCC operations. This feature has been widely appreciated and has assisted with shutdown planning and capital expenditure.

Grace provides regular on-site and off-site workshops specifically created for FCC process engineers covering the following key topics:

- Feedstock Properties
- Heat Balance
- Mass Balance
- Pressure Balance
- Unit Optimisation
- Operating Modes
- Resid Processing
- Troubleshooting Strategy

Technical Service **Team**

Europe, Middle East and Africa (EMEA)

Grace Catalysts Technologies primarily serves its EMEA customers through regional headquarters in Germany, Dubai and Moscow.

Diversity is an important feature of our technical service team in EMEA.

Our customers are diverse, so our technical team needs to be too.

Our technical service team comes from a multitude of backgrounds, including international oil companies, engineering houses, process licensors, as well as other catalyst companies, to give our customers the widest breadth of experience possible.

Our team consists of 15 nationalities, based in **12 different locations** in the EMEA region, in most cases speaking the same language as their customers.

With close proximity to their customers, our technical service team regularly make site visits, and are able to respond quickly to customer needs

Technical Support
Case Study

Refiner A observed significant catalyst losses on the regenerator side almost at the same time that they switched to a new FCC catalyst. The question arose whether the catalyst change was responsible.

Grace investigated the situation and came with the following findings:

- the refinery had previously revamped the regenerator cyclones to improve efficiency.
- the bed level indication was uncertain due to lack of fluffing air at startup with the possibility of submergence of the counterweight valves.
- the counterweight valves were calibrated using a heavier weight.
- the unit operation had been unreliable during the period leading to loss of fines in the inventory.

Grace analyzed the situation and concluded that the problem was related to catalyst defluidization in the secondary cyclone diplegs.

Grace proposed to replace completely the catalyst inventory with a finer grade to help the unit startup. Grace also suggested to install spacers at the bottom of the dipleg to allow air to fluff the catalyst in the diplegs.

The refinery completed the recommendations, and the situation improved, however the refinery still observed similar problems to some extent. Grace then recommended to install the addition of nitrogen in the diplegs, which the refinery did. During discussions Grace also also made suggestions on their startup and shutdown procedures to minimize time, mechanical problems and future unplanned shutdown.

The refinery is now experiencing smooth cyclone operation and is thankful to Grace for the support.

Change Management: How to Minimise Risk

Grace recognises that changing the FCC catalyst represents a significant step for refiners, with inevitable concomitant risks. We therefore undertake to plan and perform a range of activities to support refineries, both before and during the catalyst change-out with the express purpose of minimising those risks and ensuring a smooth and successful transition. This comprises several elements which are illustrated here:

Logistics

Before the change-out begins our logistics department will have clarified specifics regarding shipment and delivery of the new catalyst, including for example choice of haulage company, special delivery requirements (quantity, date, time, as well as paperwork). In the event of a need for base loading of the FCCU inventory, e.g. with an additive, the schedule for this, and subsequent on-going addition rates will be agreed with the refinery in advance. Grace logistics will also make arrangements, in cooperation with the refinery, to buy back Ecat, and arrange for rework by authorised environmental reworking facilities.

With its manufacturing facility located in Worms, Germany, Grace has short-lead times for emergency deliveries, typically within a few days and very often less. This provides customers the flexibility to reformulate at short notice, if and when required.

Reference Lists

Grace is the undisputed leading FCC catalyst supplier in VGO, heavy feed/resid and hydrotreated processing operations worldwide, and has maintained this position for 70 years, since supplying the world's first commercial FCC plant in 1942.

Upon request, Grace can put refineries in contact with relevant reference users – subject to acceptance on their part. Grace frequently arranges visits by interested parties to reference FCCUs in order to share experience and thus minimise risk.

Technical Support

Grace provides a broad range of technical support activities to minimise the risk of changing catalyst. These are illustrated overleaf:

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Month 1						
DAY 1 Send Ecat to Grace	DAY 2	DAY 3 Pilot plant catalyst screening study	DAY 4	DAY 5 Send Ecat to Grace	DAY 6	
DAY 7	DAY 8 Send Ecat to Grace	DAY 9	DAY 10 Detailed technical survey	DAY 11	DAY 12 Send Ecat to Grace	
DAY 13	DAY 14	DAY 15 Send Ecat to Grace	DAY 16	DAY 17 Ecat benchmarking	DAY 18	
DAY 19 Send Ecat to Grace	DAY 20	DAY 21	DAY 22 Send Ecat to Grace	DAY 23	DAY 24 Grace technical service visit	
DAY 25	DAY 26 Send Ecat to Grace	DAY 27	DAY 28	DAY 29 Send Ecat to Grace	DAY 30	DAY 31 Catalyst trial

Month 2						
DAY 32	DAY 33 Send Ecat to Grace	DAY 34	DAY 35	DAY 36 Send Ecat to Grace	DAY 37	DAY 38
DAY 39	DAY 40 Send Ecat to Grace	DAY 41	DAY 42	DAY 43 Send Ecat to Grace	DAY 44	DAY 45 ACE™ Ecat testing
DAY 46	DAY 47 Send Ecat to Grace	DAY 48	DAY 49	DAY 50 Send Ecat to Grace	DAY 51	
DAY 52 Grace technical service visit	DAY 53	DAY 54 Send Ecat to Grace	DAY 55	DAY 56	DAY 57	
DAY 58 Grace technical report	DAY 59	DAY 60				

Before

- Detailed technical survey and critical assessment of unit performance.
- Screening study using the ACE® pilot plant to identify most suitable formulation, not just performance-wise but also from the physical properties point of view.
- Arranging reference refinery visits.
- Benchmark Ecat data and unit operation using worldwide databases.
- Yield estimates using sophisticated, state-of-the-art FCC models.
- Logistics planning including fresh cat delivery arrangements and Ecat disposal requirements.

During/After

- Frequent visits by our experienced technical service team, which provide advice on optimisation opportunities as well as troubleshooting.
- Regular discussions will take place with the refinery to provide on-going updates regarding the status of the change out and progress vis-à-vis the expected trends. These will be supported by unit operating data and our modelling work and selectivity studies.
- ACE® pilot plant study using refinery feed and Ecat samples from before and after change of catalyst to evaluate catalyst performance.
- Intensive Ecat monitoring program, with extremely quick response time, is accessible online, 24/7.
- Fine tuning of catalyst formulation if required.
- Final technical report.

Analytical Support in Troubleshooting

No other catalysts supplier can compete with the analytical capabilities that Grace provide for troubleshooting.

- As well as routine Ecat characterisation service we perform morphological analysis on samples to identify changes caused by thermal and mechanical impacts.

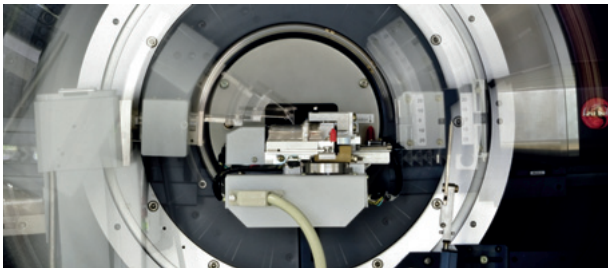
  Optical microscopy, Scanning Electron Microscopy (SEM) and SEM with Energy Dispersive X-Ray Microanalysis (SEM-EDX).

- Chemical analysis determines the chemical composition of samples in order to gain an elemental fingerprint.

  Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES).

- Phase determination ascertains the crystallographic structure of a sample to obtain information on its history.

  X-Ray Diffraction



Equilibrium Catalyst Evaluation, EMEA

Grace has the only catalyst evaluation services laboratory located in Europe.

- This allows us to offer our customers the most rapid Ecat catalyst analysis available in the EMEA region.

- Quick feedback increases the usefulness of the data to refiners, providing valuable support in monitoring the condition of the circulating catalyst inventory, and the status of FCC unit operations.

- We analyse over 7,000 Ecat samples per year from EMEA refineries.

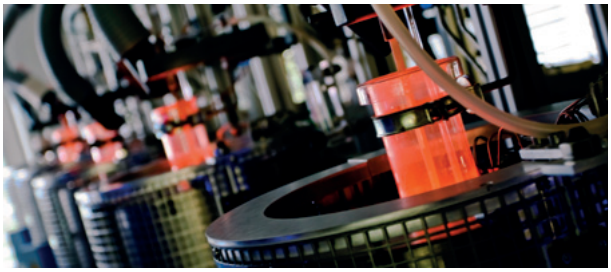
  Average duration for completion is under 2 days

- Yearly we also analyse:

  over 150 feedstock samples, over 300 slurry samples, and over 100 gasoline samples

- Analysis of such a large number of samples provides us with a large, unparalleled database which can be used to benchmark our customers' FCCU compared to industry average data.

- All these highly sophisticated analytical techniques are an essential tool for monitoring and troubleshooting the FCCU and are available to our customers.



Research & Development
Industry-Leading Facilities

- The Grace R&D centre in Worms, Germany is entirely focused on our EMEA FCC customers. It is home to highly skilled and creative chemists, chemical engineers and technicians. They are supported by advanced facilities and equipment located in our R&D centres in the USA.
- Our R&D excellence is demonstrated by Grace being the only supplier that has successfully commercialised rare-earth-free catalysts.
- Grace is at the forefront in the development of test methods associated with FCC catalysts. We developed Cyclic Propylene Steaming (CPS) procedures to simulate the deactivation of catalysts in FCC units.
- A Short Contact Time (SCT) MAT test has been developed to specifically address the challenges of short contact time FCC technology.
- Bench-scale pilot testing of catalysts and feeds can be performed in fluidised bed Advanced Catalyst Evaluation (ACE®) units.
- On a larger scale Davison Circulating Riser (DCR) pilot units have been developed in-house by Grace. These are now used as the industry standard, and have been licensed to over 25 units worldwide.
- These test methods allow accurate prediction of the performance of different catalyst technologies in FCC units for different feed qualities at various contaminant metals levels.
- Grace licenses and sells certain test methods. Our experts regularly support customer laboratories in establishing state-of-the-art testing facilities.

Logistical Support
Life Cycle Management

- Our logistical support team for EMEA customers is located in Worms, Germany, alongside our manufacturing facilities. This close working proximity provides our customers with a more effective and efficient logistical support. Critically it can ensure customers have access to products at very short notice – within a matter of days, sometimes hours – as is sometimes required in the event of a unit upset.
- Grace has a permit to collect, store, handle, reprocess and re-sell Ecat and fines generated from fresh FCC catalysts manufactured from Grace Europe.
- Therefore Grace is uniquely positioned to be able to provide large quantities of premium and standard quality Ecat, as well as Ecat fines.
- For Ecat high in contaminant metals, Grace has an agreement to rework such materials through various outlets.

Fully in compliance with new REACH requirements

www.grace.com

World Headquarters

W. R. Grace & Co.-Conn.
7500 Grace Drive
Columbia, Maryland 21044/USA
Tel.: +1 410 531 4000
NA Toll Free: +1 800 638 6014

Europe

Grace GmbH & Co. KG
In der Hollerhecke 1
67545 Worms/Germany
Tel.: +49 6241 403 00

Grace is a leading global supplier of catalysts; engineered and packaging materials; and, specialty construction chemicals and building materials. The company's three industry-leading business segments – Grace Catalysts Technologies, Grace Materials Technologies and Grace Construction Products – provide innovative products, technologies and services that enhance the quality of life. Grace employs approximately 6,000 people in over 40 countries.

Grace has met all REACH requirements for the given deadline for Tier 1, December 1, 2010, and can hereby assure today's and future customers full REACH compliance of its products. This assurance also includes the very diverse use of a spectrum of our products.

GRACE

Enriching Lives, *Everywhere.*®

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