

# OILS, FATS & OLEOCHEMICALS

Catalysts & Services – Accelerating Your Chemistry®







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### ACCELERATING YOUR CHEMISTRY®

Catalytic processes take place behind the scenes, reducing activation energy and accelerating chemical reactions. Yet catalysts never appear in final products. This ability to reduce activation energy while remaining invisible is expressed by our Purple Box.

The purple box symbolizes performance in five dimensions:

#### TAILORED SOLUTIONS

Your goals, needs and wishes are unique – we'll develop the right solution for your process.

#### SPEED

Time is of the essence for our customers – our teams react swiftly and flexibly to your special wishes. Irrespective of whether the catalyst is based on your recipe or ours, we specialize in scaling-up and on producing sophisticated catalysts on a commercial scale.

#### STRENGTH

Evonik catalysts are always heavy-duty performers – you can count on our strength as well as the power of our catalysts.

#### LONG LIFE

Efficiency and long-term reliability are decisive for catalytic processes – that's why Evonik catalysts are always designed for a long service life.

#### SERVICE

Technical customer service, high throughput screening, metal recovery – Evonik catalysts come with a full service package.





## TOGETHER WE BRING CATALYST IDEAS TO LIFE

Catalysts: the No. 1 value generator in the chemical industry. More than 80 percent of all chemical products are manufactured by means of catalytic processes. Expertise in harnessing the power of catalysts is second nature to us – we can help you significantly reduce energy and resource consumption, or develop new products. As an international leading provider of catalytic technologies, we serve the markets:

- Life Sciences & Fine Chemicals
- Industrial & Petrochemicals
- Polyolefins



## EVONIK INDUSTRIES AT A GLANCE...

Evonik, the creative industrial group from Germany, is one of the world leaders in specialty chemicals. Profitable growth and a sustained increase in the value of the company form the heart of Evonik's corporate strategy. Its activities focus on the key megatrends health, nutrition, resource efficiency and globalization. Evonik's customers benefit

from its innovative products and integrated technology platforms. Evonik is active in over 100 countries around the world. As part of Evonik Resource Efficiency GmbH, the Business Line Catalysts lives up to the principles of resource efficiency. Our products enable and continuously improve production efficiency.

SALES 2017:

14.4 billion

ACTIVE IN OVER:

100 countries

EMPLOYEES: more than

36,000

### EVONIK IS A MEMBER OF

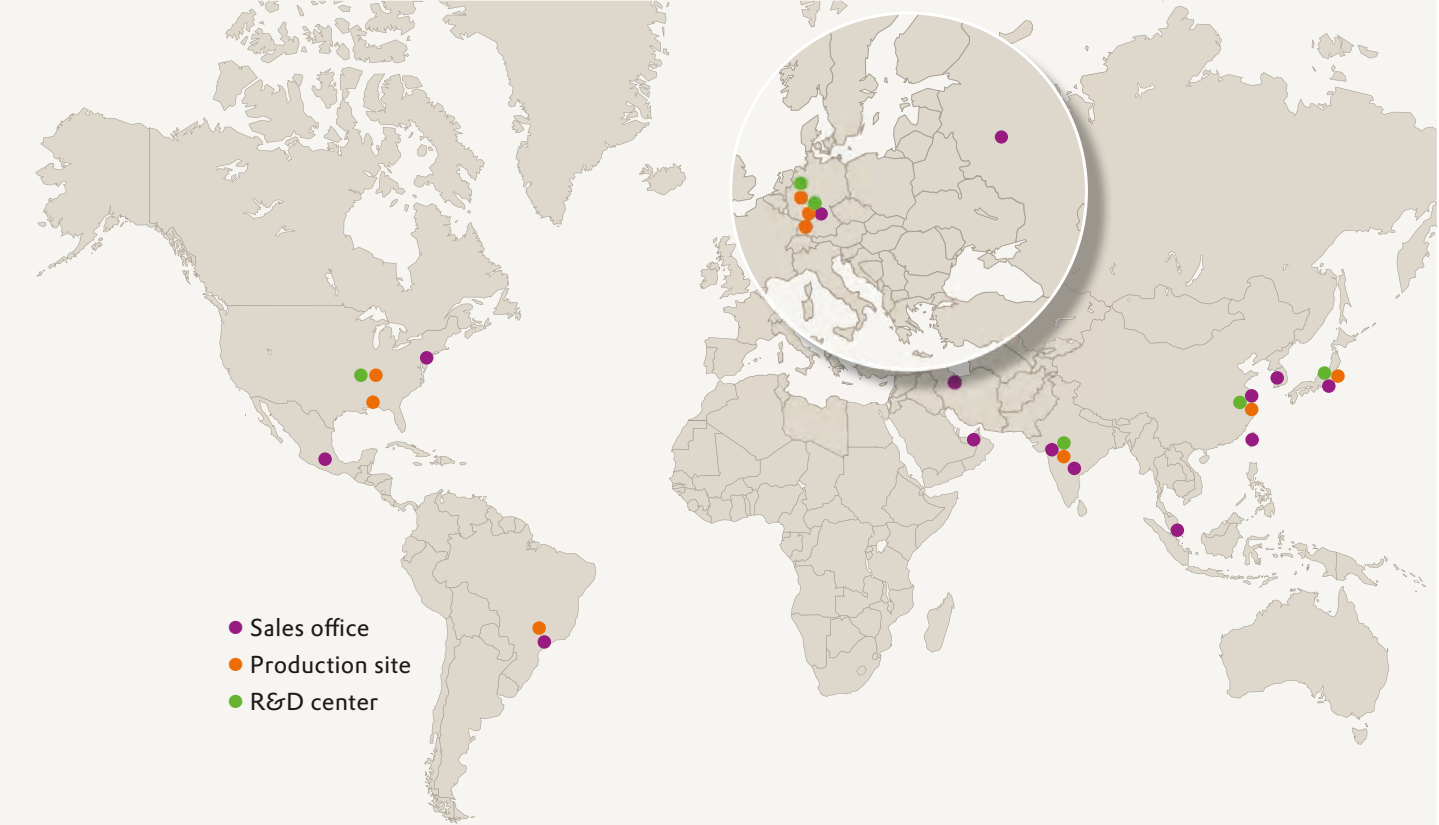
- the European Catalyst Manufacturers Association (ECMA)
- the Catalyst Manufacturers Association of Japan (CMAJ)
- the Synthetic Organic Chemical Manufacturers Association (SOCMA)
- the Drug, Chemical & Associated Technologies Association (DCAT)
- the American Chemistry Council (ACC)
- the Catalysts Society of Japan (CSJ)

# MARKETS & BRANDS

Today, Evonik has eight major catalyst brands for homogeneous and heterogeneous catalytic processes under one roof. This diverse portfolio of catalysts gives us the flexibility to find the most cost-efficient solution for your needs. With its catalysts for batch, semi-batch and continuous processes, Evonik serves the following markets:

	Life Sciences & Fine Chemicals	Industrial & Petrochemicals	Polyolefins
Aerolyst®		●	
catMETium®	●		
Catlyen®			●
KALCAT™	●	●	
Metalyst™ MC	●	●	
MONCAT™	●	●	
Noblyst®	●	●	
Octolyst®		●	

# GLOBAL PRESENCE



## OUR MISSION

“Together we bring catalyst ideas to life, creating value by our passion and focus.”

## OUR VISION

“To be globally recognized as the preferred partner for major catalyst users, and to develop and attract talented people for our international team.”





# BUSINESS MODELS

We have built our business models around your needs in relation to catalyst solutions. There are two business models; the product and the project business.

## PRODUCT BUSINESS

- Products from our portfolio
- Evonik proprietary products and production know-how
- Ready to use

## PROJECT BUSINESS

Catalysts that are customized in close cooperation with the customer

True partnership for optimized catalyst solutions



In both business models, we leverage our core competencies. We are creative in finding new solutions and are open to ideas that are not obvious. We specialize in scaling up and producing sophisticated catalysts on a commercial scale.

### Our core competencies:

- Designing robust, high performance catalysts
- Producing in commercial quantities
- Delivering on our promises
- Professional project management



# CUSTOM CATALYSTS

Over the last two decades the demand for custom specific catalysts has increased dramatically. When the need for a custom catalyst arises, we leverage our core competencies in the context of a project. We are creative in finding new solutions and are open to ideas that are not obvious at first glance. Evonik specializes in scaling up and producing sophisticated catalysts on a commercial scale. A robust and stable production process is crucial to all catalysts, and we know how to design and operate this. The best catalyst in the laboratory is of no use if it cannot be produced in commercial quantities. Reliable, delivering on our promises, our professional project management with cross-functional teams makes the project flow smoothly. We are never complacent about our achievements and continually strive for constant self-renewal in our business processes for your benefit.

## Project Categories

### Joint Development

Catalyst and process needs to be developed; close interaction between you and Evonik

### Custom Design

Catalyst needs to be developed for existing commercial application

### Custom Manufacturing

Catalyst lab recipe exists, but has not yet been produced commercially

### Toll Manufacturing

Catalyst and manufacturing process is well defined

## Characteristics of a project

- A confidentiality agreement protects each party's intellectual property rights and allows a free flow of information
- A collaboration agreement defines the scope and goals of the project and the commercial conditions
- By definition, all projects run on an exclusive basis

## How you benefit from custom catalyst projects:

- Allows you to concentrate on your core business
- Provides you with a skilled partner for developing and scaling up of catalysts
- Access to sophisticated catalyst manufacturing equipment
- Offers greater flexibility in the use of catalyst types and quantities
- De-bottleneck your own catalyst production





### MONCAT™ Samples

We provide samples as per customers' requests up to 1 kg sent in the appropriate packaging for worldwide delivery. Please contact your Evonik representative for catalyst recommendations and additional information.

## THE MONCAT™ BRAND

MONCAT™ products are supported reduced nickel catalysts embedded in hydrogenated vegetable oils and delivered in the form of pastilles. They are free of water, easy to handle and provide high yields of the desired products. Our catalysts are sold worldwide for the hydrogenation of plant and animal oils and fats for the manufacture of soaps, oleochemicals, vanaspati, margarine, stearic acid, 12-hydroxy stearic acid and many other products. Special MONCAT™ grades are available for different hydrogenation reactions to produce edible and oleochemical products alike.

Our catalysts have been developed to provide solutions to our customers' needs, based on our close communication and cooperation with them. For Evonik, product development and innovation are ongoing processes in order to continuously meet the changing demands of the marketplace. Timely customer and technical services completes the MONCAT™ portfolio.

MONCAT™, in other words, is more than a symbol of excellent performance – it also stands for continuous development in close collaboration with our customers.

### MONCAT™

Product	Ni content	Reaction
MONCAT™ 1991	> 23%	Full and partial hydrogenation of fatty acids
MONCAT™ 2021	> 21%	Full and partial hydrogenation of triglycerides
MONCAT™ 2991	> 23%	Hydrogenation of monomer and dimer fatty acids
MONCAT™ 3921	> 17%	Partial hydrogenation of triglycerides
MONCAT™ 4181	> 17%	Sulfur doped for the partial hydrogenation and isomerization of triglycerides



## INTRODUCTION TO OILS AND FATS HYDROGENATION

The hydrogenation of fats and oils is carried out for two main purposes. The first reason is to increase the stability of the fat or oil so that it can be stored longer without becoming rancid and the second reason is to adjust its melting point as well as texture for use in functional foods and oleochemicals. These fats and oils predominantly originate from plants, however some of them are rendered from animals such as fish, cattle and other livestock.

Fats and oils exist as triglycerides (aka, triacylglycerides) with a glycerol back bone that is attached to three fatty acids via acyl linkages. The difference between a fat and an oil is that a fat is solid at room temperature and the oil is not. The melting point of the fat or oil is dependent on the following factors with decreasing importance; level of trans or cis configuration for the double bonds, the number of double bonds and the number of carbon atoms in the fatty acid chains. The number of double bonds is measured by titrating them with iodine to be reported as the grams of iodine adsorbed by 100 grams of fat or oil and is better known as the iodine value (IV). The higher the IV, the higher the number of double bonds in the triglyceride and the higher the level of unsaturation. The fatty acid chains can have 0, 1 (monoenes), 2 (dienes) or 3 (trienes) double bonds each. Practically all double bonds in nature are in

the cis configuration meaning that the largest groups are on the same side of the double bond and trans double bonds with the largest groups on opposite sides can be synthetically produced during hydrogenation to form trans fatty acids (TFA). The air oxidation rate with fats and oils to form hydroperoxides (that cause rancidity) is much higher for trienes than dienes and that of dienes is much faster than monoenes.

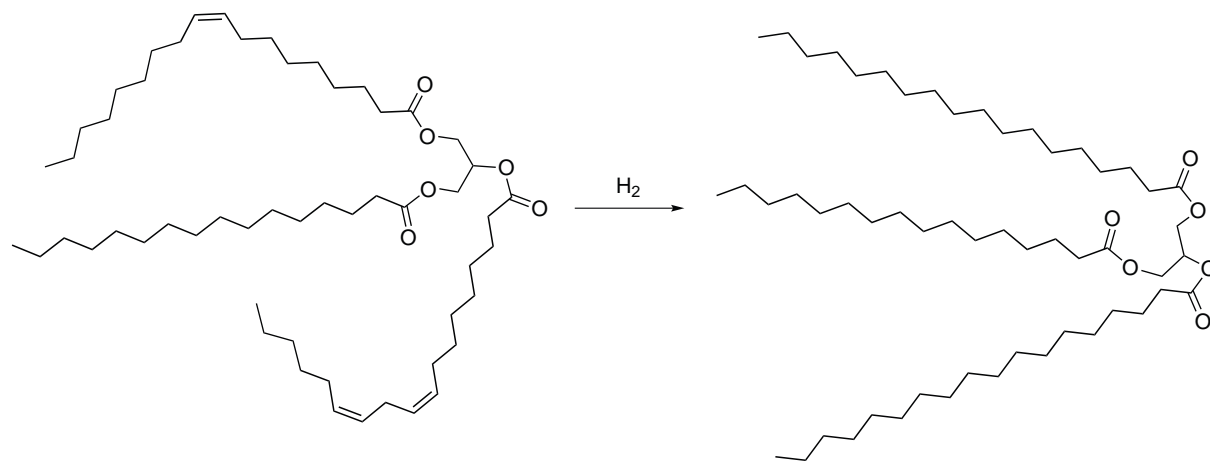
Fully hydrogenated oils (FHO) are made by the addition of hydrogen to the double bonds so as to convert trienes, dienes and monoenes to saturated oils (aka, saturates) with nearly no double bonds ( $IV < 0.5$ ). Partially hydrogenated oils (PHO) are made by the selective addition of hydrogen to double bonds so as to convert trienes and dienes to monoenes with very little saturates. The production of some PHO types can also require double bond isomerization from cis to trans thereby creating TFA with the desired steep melting curve. Each source of fats and oils require different amounts of hydrogen to produce FHO and PHO since all of them have different IV values. Triglycerides can also be split into free fatty acids (FFA) and then hydrogenated to oleochemicals. The catalyst required for this hydrogenation is different than that for triglyceride hydrogenation and this will be discussed in the next sections.







### The full hydrogenation of an unsaturated triglyceride to a saturated one



### Hydrogenated edible oil applications:

- Shortening for pastry-making industry (puff pastry – cake shortening, pastries)
- Ingredients in confectionery i.e. compatible with cocoa butter, chocolate coating
- Hardstock for Ghee (Vanaspati) production
- Constituent of spreadable butter
- Partial or brush hydrogenation to use as salad oil or low trans fats
- (hydrogenated oil blended with liquid oil)

## EDIBLE OIL HYDROGENATION

Edible oils are mainly vegetable and sometimes animal oils, that have been refined and modified to remove undesirable impurities in order to make them suitable for human consumption. Some of these processes include plant extraction or animal rendering, degumming, caustic refining, bleaching, deodorization and hydrogenation. Edible oils are hydrogenated in the form of triglycerides (please see reaction scheme on this page) to produce either fully hydrogenated oils (FHO) or partially hydrogenated oils (PHO). FHO can be used for food preparation or for interesterification with unsaturated oils to produce “trans fatty acid

(TFA) free” functional foods with the desired melting points and textures. PHO also have modified melting points and textures so that they can be used as coconut butter equivalents (CBE), coconut butter substitutes (CBS), coating fats and other specialty fats. PHO may contain TFA and this needs to be controlled with the appropriate catalyst and reaction conditions. MONCAT™ 2021 is the preferred catalyst for both FHO and PHO, while MONCAT™ 4181 is preferred for PHO.





## OLEOCHEMICAL PRODUCTION VIA HYDROGENATION

Oleochemicals are not for human consumption and are either fully (IV < 0.5) or partially hydrogenated free fatty acids (FFA). This can be accomplished by either first hydrogenating the triglycerides followed by splitting them to FFA or one could first split the triglycerides followed by hydrogenating the resulting FFA (please see the reaction scheme on this page). These two routes are very different and they require different types of catalysts.

If the triglyceride is first split to FFA and then hydrogenated, one will need to mitigate nickel soap formation by using higher pressures (~18 to 30 bars) and lower temperatures (< 200 °C). It is important to efficiently and rapidly filter off the catalyst after hydrogenation so as to minimize nickel soap formation during this step. The premier catalyst in the industry for the full or partial FFA hydrogenation is MONCAT™ 1991 due to its structure that protects it from nickel soaps.

When the partial hydrogenation of FFA is desired MONCAT™ 4181 is the catalyst of choice.

Initially reducing the triglyceride and then splitting to the partial or fully hydrogenated FFA avoids nickel soap formation, however triglycerides are larger molecules than FFA and the catalyst's pore structure needs to reflect this difference. Moreover, triglycerides contain only 94 to 96 % of the desired fatty acid chains, meaning that 4 to 6 % more mass needs to be hydrogenated if one uses this route. MONCAT™ 2021 is the preferred catalyst for the partial or full hydrogenation of triglycerides and MONCAT™ 4181 is the choice for triglyceride partial hydrogenation.

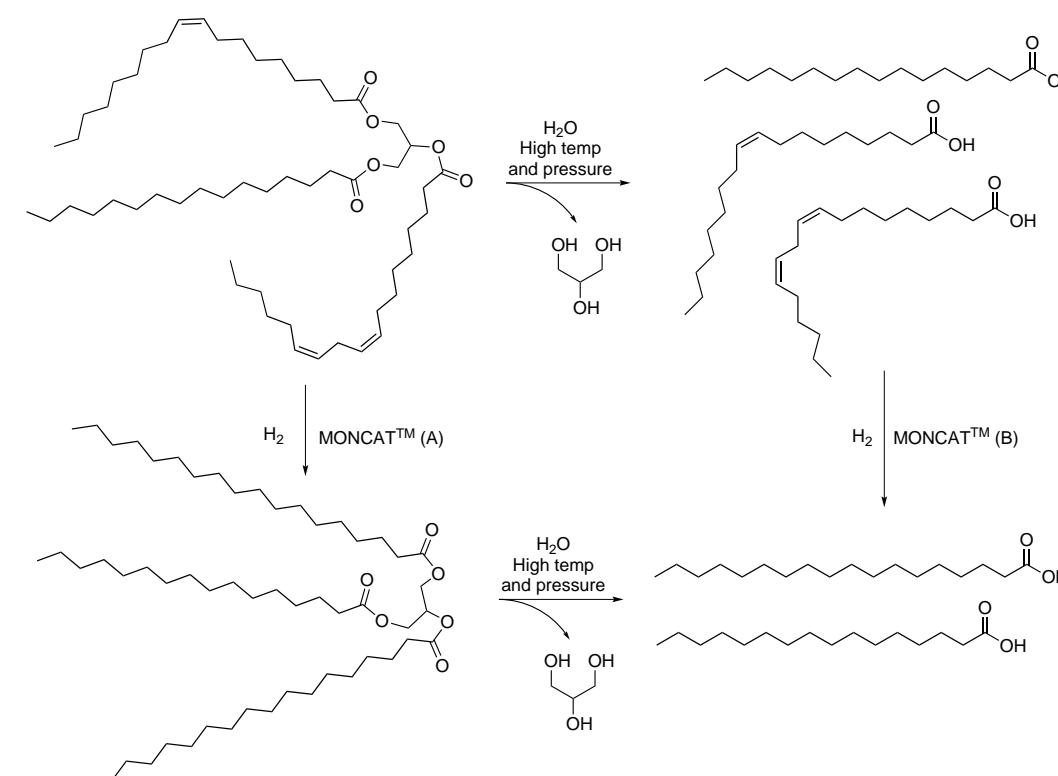
The hydrogenation of castor oil followed by splitting it to 12-hydroxystearic acid is a special case where the hydrogenation step is very mild (< 160 °C and >10 bars) to avoid losing hydroxyl groups. The preferred catalyst for castor oil hydrogenation is MONCAT™ 2021.



### Applications for hydrogenated oleochemicals:

- Hydroxystearic acid widely used in manufacturing of lubricants, cosmetics etc.
- Stearic acid utilized in the manufacture of rubber tires and other molded rubber products.
- Stearic acid along with hydrogenated castor derivative provided for the manufacture of textile softeners for textile sizing.
- Stearic acid used in the form of metal stearates for metal surface treatment/finishing and to coat the metals used in fireworks to prevent oxidation.

### Two routes to saturated free fatty acids







## SPENT NICKEL CATALYST REFINING

Evonik Catalysts India has a dedicated facility for recovering nickel from spent nickel catalysts that were used for processing oils and fats as well as polyols. Evonik Catalysts India purchases your spent catalyst based on the percentage of nickel, where the higher concentrations of nickel receive a higher percentage of nickel LME. The best results are achieved when the spent catalyst residue contains 10 % or more of nickel. This service allows the customer to effectively dispose of the spent catalyst, while recovering some of the nickel value.

The availability of this service depends on the local laws and regulations of the customer. Please contact your Evonik Catalyst India representative for further details.

**EVONIK RECEIVES**  
a sample of the spent  
catalyst for the initial  
analysis

**RECEIPT OF SPENT NICKEL**  
after both parties agree on  
the initial value of the spent  
catalyst

**WEIGHING & SAMPLING**  
of spent consignment

**NICKEL CONTENT  
ANALYSIS**  
to confirm the value of  
the spent catalyst

**CUSTOMER  
RECEIVES PAYMENT**  
based on LME\* data and  
the concentration of  
nickel in the spent catalyst

\* London Metal Exchange; [www.lme.com](http://www.lme.com)



# PACKAGING & STORAGE

Standard packaging size	Exports: 175 kg in steel drums or 650 kg/750 kg in Super Sacks. Domestic: 25 kg in bags or 50 kg in extreme climate resistant fiber drums.
Storage	The catalyst must be stored in a shaded well ventilated area that does not experience extreme temperatures. The catalyst must not be stored in direct sunlight.

# MSDS AND DATA SHEETS

Material Safety Data Sheets	Material Safety Data Sheets (MSDS) and Data Sheets can be obtained from your local sales representative or from:	Evonik Resource Efficiency GmbH Postcode 713/303 Product Safety Department Rodenbacher Chaussee 4 63457 Hanau-Wolfgang Germany FAX +49 6181 59-4205 sds-im@evonik.com
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# ESHQ

Environment, Safety, Health and Quality	As a subscriber to the Responsible Care® program, Evonik is committed not only to delivering quality products and services but also to maintaining high health, environmental, safety and security standards in the operation of its plants and distribution of its products. Our sites have ISO 9001 and ISO 14001 certification, and all our US sites are certified in	accordance with the RC 14001 standard. Certain products are also Halal and Kosher certified. We take pride in promoting the principles and practices of Responsible Care® by sharing experiences and offering assistance to others who produce, handle transport or dispose of our products.
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# OTHER BROCHURES

Additional Services	For access to more of our publications please contact your local sales manager or visit our website at <a href="http://www.evonik.com/catalysts">www.evonik.com/catalysts</a>
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**EVONIK RESOURCE EFFICIENCY GMBH**

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