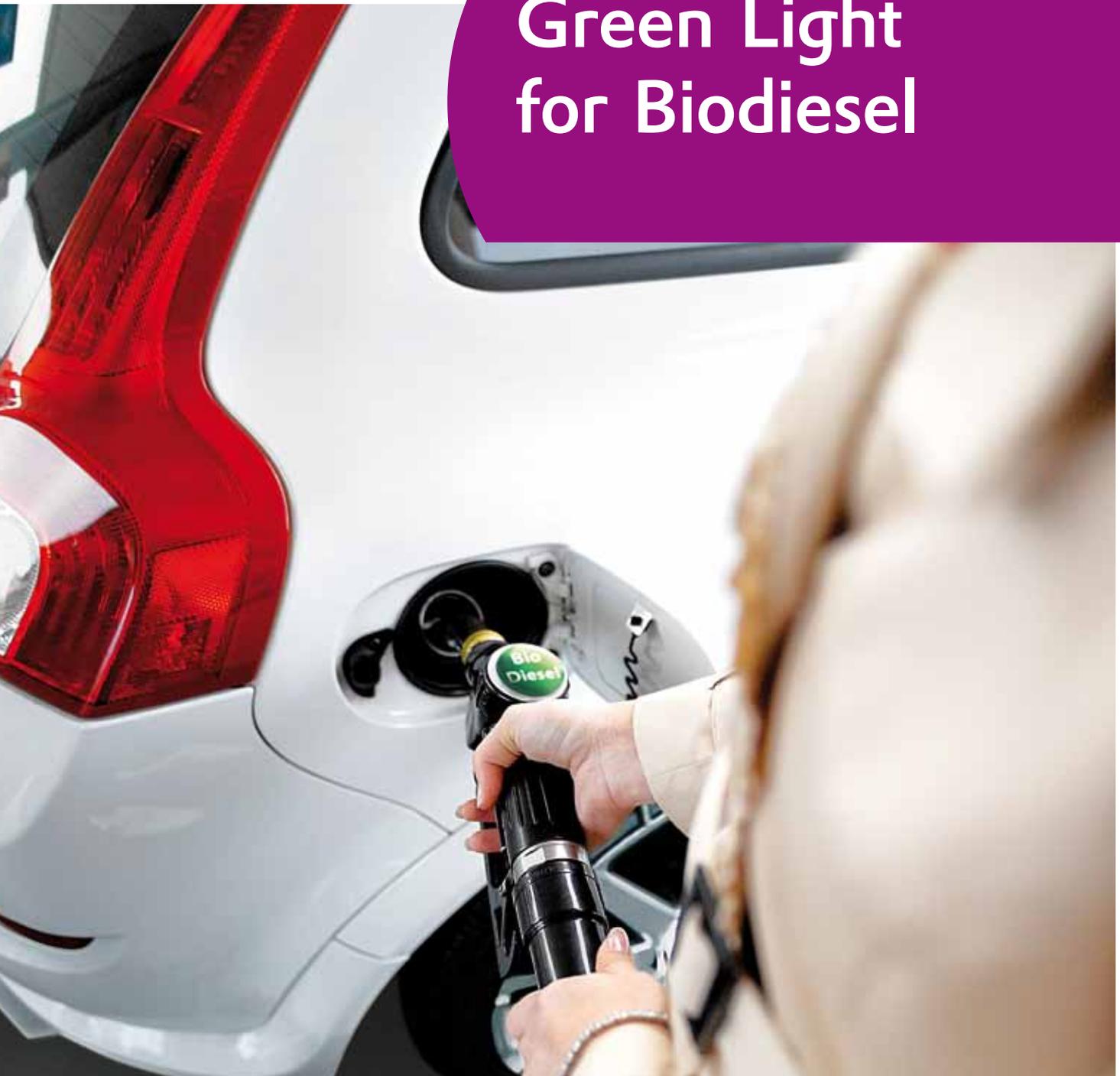


Green Light for Biodiesel



Evonik

Evonik is the creative industrial group from Germany with business activities all over the world. It is managed with courage and determination. To create our own perspectives, we leave the beaten path and win over new markets with groundbreaking ideas.

Evonik. Power to create.



Contents

- 2 **Evonik. Power to create.**
- 3 **Innovations for the world of tomorrow**
- 4 **Biodiesel**
Green light for a future-oriented fuel
- 6 **Rapeseed, Soy & Co.**
The source material
- 7 **Transesterification**
From vegetable oil to high-tech fuel
- 8 **Alkoxides**
High-performance catalysts in the transesterification process
- 10 **Defoamers**
A winning team in each additive packet
- 13 **Cold Flow Improvers**
Superior at every temperature
- 16 **Special polyamide 12 compounds**
Paving the way for the new generation of fuels
- 18 **Process Technology & Engineering**
Specialists for your special needs
- 19 **Certification**
The promise of quality - in writing

Innovations for the world of tomorrow

Evonik Industries is one of the worldwide leading companies in specialty chemicals. The company's six business units possess a broad product portfolio – from synthetic building blocks to superabsorbents, from high-performance plastics to additives for petroleum- or natural oil-based fuels. With 34,000 employees worldwide, we operate our own production plants in some thirty countries, and generate more than 80 percent of our sales from a market-leading position.

Specialty chemicals are the base materials of today's product innovations. The investments we make year after year in research and development are extraordinary. As are the results. About 20 percent of our chemical sales are made with products and applications that are less than five years old. They ensure our strong position in the fiercely competitive specialty chemicals market. And guarantee you growing added value and the competitive advantage so often decisive today in your markets.

Biodiesel

Green light for a future-oriented fuel

The search for alternative sources of energy is a megatrend that will have a permanent impact on the developments of the coming years and decades. Many chemical companies, not to mention legislators, have aligned their strategies accordingly. Among the many controversial energy sources out there, and those that are still in the development stage, one has long since pulled away from the pack: biodiesel. In many countries, this environmentally friendly fuel is already a mandatory addition to mineral diesel. With increasing percentages, biodiesel promises increased climate protection and less reliance on imports.

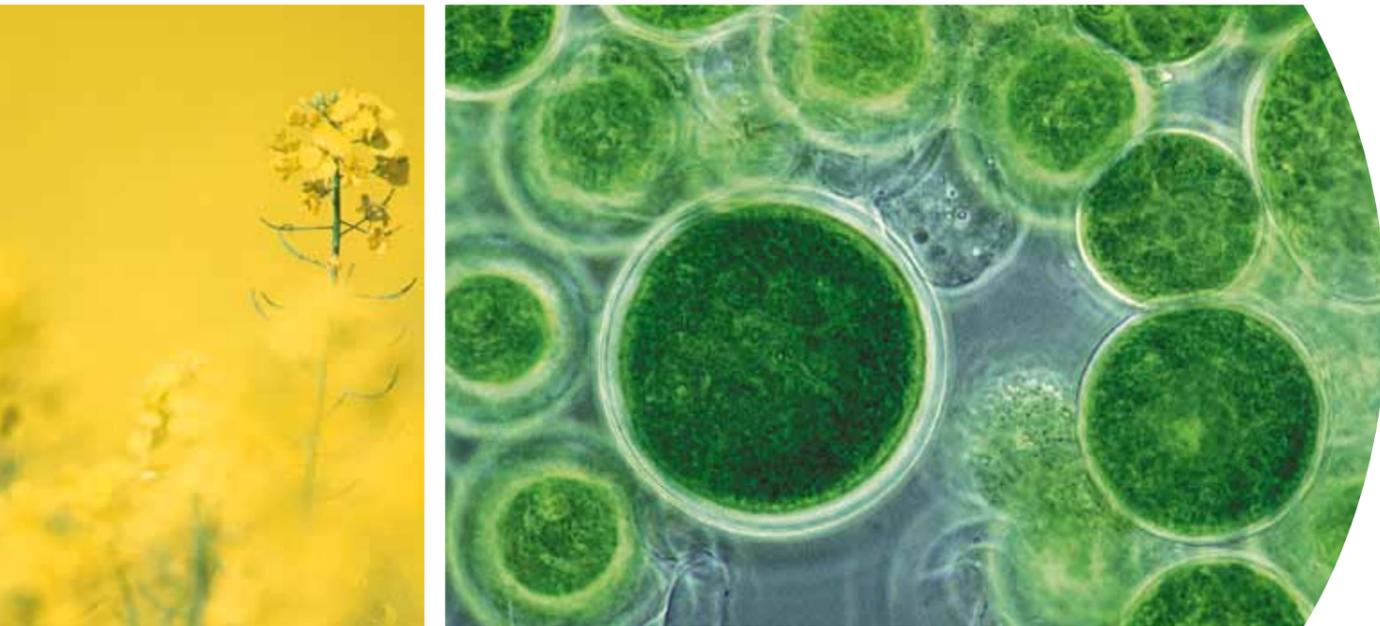
We're committed to this promising growth market – with our capabilities as a worldwide leader in specialty chemicals, our innovative drive as a visionary supplier of customer-oriented solutions, and our ambition to create sustainable value. We've been actively involved in biodiesel ever since commercial production began.

Today, our knowledge and achievements in the area put us at the forefront of continued development and growth. Our biodiesel portfolio covers a broad spectrum of outstanding products, designed for producing and using this "green" fuel:

- Alkoxides as catalysts for efficient transesterification
- Defoamers for effective use in multi-functional diesel additive packages
- Cold Flow Improvers for outstanding low-temperature properties in any region, and any season
- Special polyamide 12 for adapting automotive components to biodiesel
- Process technology consulting services in all related areas of expertise

The net result: solutions that clearly position biodiesel as a viable, high-quality, high-tech fuel – even for today's diesel engine generations with common rail or unit injector injection systems.





Rapeseed, Soy & Co. - the raw material

Biodiesel, Ecodiesel, Diesel-Bi – these are just some of the names out there for a non-petroleum diesel fuel with increasing significance worldwide, especially as an admixture in fossil diesel. Its chemical term is FAME* and it's created from native vegetable oils or animals fats, as well as recycled cooking oils.

*Fatty Acid Methyl Ester

Soy from North and South America, rapeseed from Europe, palm oil from Asia are the most important raw material sources for the biodiesel industry. Animal fats and recycled cooking oils are also used. Recently, more focus has also been placed on second-generation raw materials (jatropha and algae oil). Vegetable oils are converted at a 1:1 proportion to the corresponding methyl esters.

These native oils are outstanding starting materials for biodiesel. The biofuel obtained from them stands out for the following properties:

- Very good inherent lubricity
- Lower particulate matter, carbon monoxide and hydrocarbon emissions
- Almost sulfur-free
- Biodegradable, non-toxic
- Recommended for use in water protection areas

From vegetable oil to high-tech fuel: transesterification

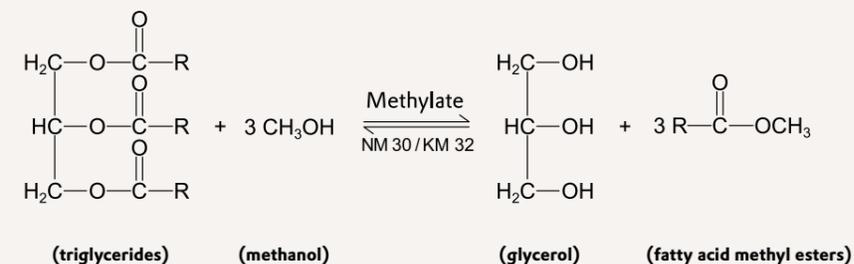
The molecular structure of vegetable oils in their pure form precludes their use for conventional combustion diesel engines. Vegetable oils – just as animal fats – consist of triglycerides, that is, the combination of the trivalent alcohol glycerol with three fatty acids.

The key is to replace the trivalent glycerol with a monovalent methanol. This transforms the viscous vegetable oil into a fuel with excellent flow characteristics: **biodiesel**.

And all it takes is a simple chemical reaction called transesterification, which involves mixing methanol with a small quantity of an alkaline catalyst. Here, sodium methylate 30% solution in methanol (NM 30) and potassium methylate 32% solution in methanol (KM 32) from Evonik have become the industry's preferred choice.

The quality of the vegetable oil determines the efficacy and cost-efficiency of these catalysts. To prevent undesired side effects, such as soap formation, or increased catalyst consumption, the crude oil should be refined to a water content of max. 0.1% and a free fatty acid (FFA) content of max. 1% preferably 0.1%.

In addition to biodiesel, transesterification also yields glycerol as a valuable by-product for the pharmaceutical and cosmetics industry.





Alkoxides

High-performance catalysts in the transesterification process

Alkoxides have been used to transesterify vegetable oils since 1852. With the growing importance of biodiesel, the process has been optimized to the extent that now various raw vegetable oils can be transesterified to biodiesel and glycerol with higher yields and better product quality. Here alkoxides from Evonik are making the difference. As the world's leading producer of specialized intermediates, we offer advanced catalyst solutions specifically designed to address the requirements of producing biofuels. The added value: high yield, simple, safe handling in a closed circuit combined with significant gains in efficiency and productivity.



NM 30 and KM 32: the leading catalysts

Sodium methylate 30% solution in methanol (NM 30) is the leading component in the transesterification of vegetable oils. Approximately two-thirds of the capacity of large-scale production plants (50,000 to 1 million metric tons/year) is set up for this catalyst, and continues to grow. For processes using raw material with an FFA* content of more than 1.0%, such as used cooking oils or animal fats, Evonik proposes potassium methylate 32% solution in methanol (KM 32). Both catalysts can be used in anhydrous production processes and directly from the storage tank – in a closed circuit and without any additional intermediary steps. This reduces handling risks to an absolute minimum.

Alkoxide catalysts NM 30 and KM 32 are also the preferred choice because of their cost-efficiency. Supplied ready for use, they save an entire production step in the making of biodiesel fuel that would otherwise be required for dissolving the catalyst in the methanol. The powerful alkoxides from Evonik also pay off by increasing biodiesel yields by 2 to 5%, and generating higher-purity glycerol. The latter is actually obtained with a technical purity of 80–85%. The higher purity makes an important contribution to the cost-effectiveness of a biodiesel plant.

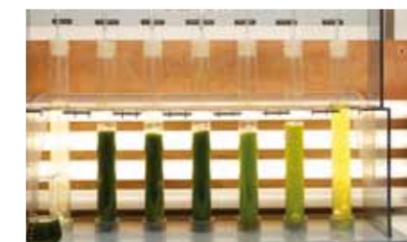
Service: expect a lot

Biodiesel catalysts from Evonik are backed by the roughly 40 years of expertise in manufacturing alkoxides, plus more than 17 years of experience in addressing various challenges of the biodiesel industry. They are also the result of significant investments in research and development, especially with a focus on biodiesel based on promising second-generation raw materials, such as jatropha or algae oil. But most importantly, behind our market-leading alkoxides you have the minds of the people at Evonik, who are excited about their work, and support you with knowledge and experience – whether in application engineering, specification-compliant production of biodiesel, or optimizing production facilities.

The analytical lab of Evonik, with all its technical facilities, from chromatography to titration and more fuel related analyses, is also at your disposal to make your product meet all relevant specifications.

Proximity: the advantage of a global partner

Proximity to your production facility is an important advantage – not only because you may sometimes need to address urgent bottlenecks. As a global player, we're in 50 countries around the world, and everywhere in the Americas, Asia, and Europe. This not only means outstanding availability and short lead time, but also that we speak your language – regardless of where your biodiesel plant is located.





Defoamers

A winning team in every additive package

Excessive foaming, reduced filling capacity, longer filling times, and thus reduced productivity at the fuel pump – these are the main reasons why defoamers have become a key component in multifunctional diesel additive packages (DAP). And yet the requirements of defoamers today are anything but standard. Additive packages are constantly being adapted to new specifications to extract more energy from fuels – and to maintain their effectiveness with every new engine generation and further reduce emissions. That’s why defoamers are being constantly refined for better performance and greater cost-effectiveness. Defoamers that meet these demands are known under the brand name TEGO® Antifoam.

TEGO® Antifoam: tailored foam brakes

TEGO® Antifoam is a family of high-performance defoamers for diesel fuels and biodiesel blends. Based on the latest organo modified siloxane technology, these products are tailored for diverse diesel qualities and additive combinations. TEGO® Antifoam defoamers provide excellent properties: long time performance, package stability, and solvent compatibility.

They are also characterized by outstanding results which they achieve in BNP and filtration tests. Here, TEGO® Antifoam MR 465 and MR 467 lead the charts. Highly effective in both dry (low lubricity) and wet diesel, they unfold their defoaming action in concentrations as low as 4–6ppm, in most cases without requiring additional solvents. TEGO® Antifoam MR 467 currently sets the efficacy and efficiency standards for advanced high-performance diesel with a cetane index above 60. We offer TEGOPREN® 5851 as a cost-effective alternative for use with mainly dry diesel.

Active ingredient: built-in efficiency

Cost-effectiveness is a primary focus in the development of our defoamers – accepting no compromise of performance. The result: TEGO® Antifoam defoamers are highly active even at low dosages. Particularly for wet diesel they deliver significant benefits in terms of foam height and collapse time. And they significantly reduce the requirement for other additive components, such as solvents. TEGO® Antifoam products are able to reduce the solvent content by up to 30%.

Service: flexibility at your command

Because we are the leading supplier of defoamers, you can expect more from us than excellent products. Our mutual beneficial concepts of partnerships spark innovative solutions in applied laboratory and R&D projects. Our service includes final specification checks as well as BNP test series of your DAPs.

New innovation: defoaming B7 diesel

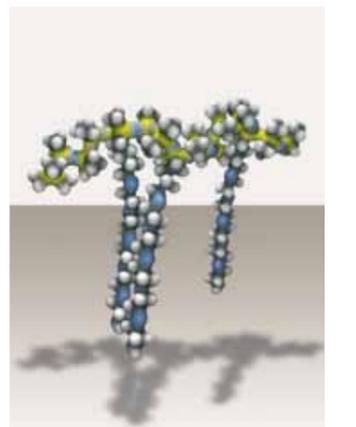
The latest member of our diesel defoamer family is TEGO® Antifoam MR 507. This product is especially designed to defoam diesel fuels with high amounts of bio components regardless of their individual raw material source.

Know-how: the key to successful innovation

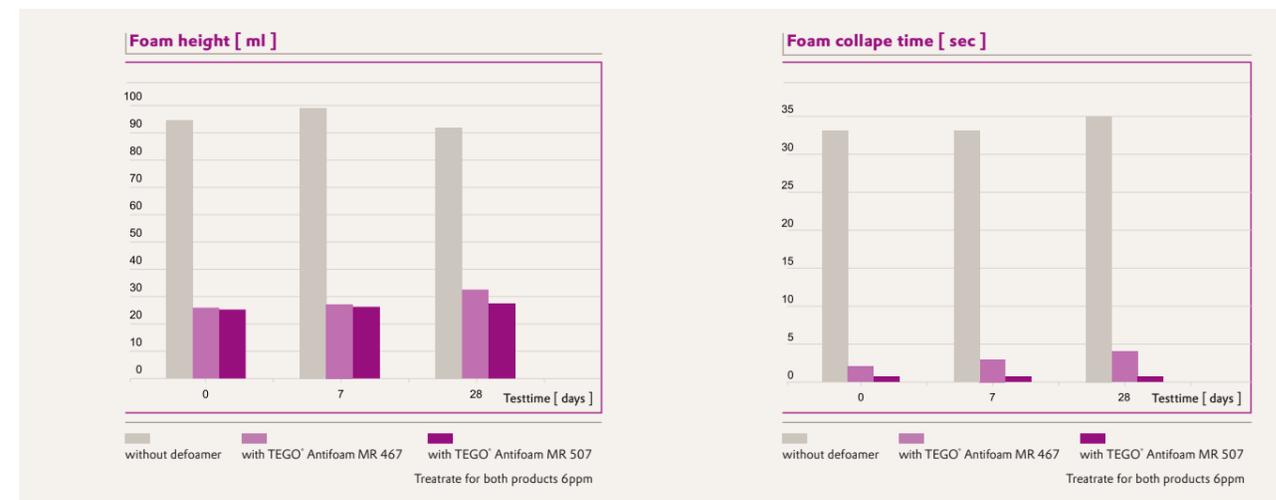
For more than 3 decades Evonik Industries has been supplying formulators of the diesel market with superior solutions in the field of defoaming. Being a think-tank with proprietary access to broad technology platforms, we have emerged to become a unique supplier offering innovative products. With our formulating experience and your knowledge in the market we help you to develop your next product generation.

We nurture long-standing development partnerships with leading package manufacturers and work closely together with universities and research institutes, delving even deeper into effective foam inhibition. Our goal remains unchanged: to make tomorrow’s defoamers even more efficient and more effective for use in multifunctional diesel additive packages.

TEGO® Antifoam defoamers are based on organomodified siloxanes. The siloxane backbone ensures low surface tension - one of the prerequisites for an effective foam inhibitor. The specific design of the organic ligands translates into improved stability and compatibility.



Defoaming performance is measured in foam height and collapse time. The standard BNP foam test proves that TEGO® Antifoam MR 507 yield to outstanding efficacy over time. For the following standard foam test (BNP test) we used B7 diesel.





Cold Flow Improvers

Superior at any temperature

Biodiesel fuels have different flow properties in cold temperatures. The reason is that biodiesel is made up of various long-chain fatty acid methyl esters (FAMES). Because their melting points vary within a broad range of about -35 to +45°C, the low-temperature properties of the biofuel can be adversely affected, depending on whether it's based on soybean, rapeseed, palm oil or animal tallow. The leading solution for this problem is VISCOPLEX® Cold Flow Improvers (CFIs), a broad spectrum of Cold Flow Improvers from the Evonik Oil Additives Business Line of Evonik Industries. They provide outstanding flow properties for your biofuel - in any region or season. And they mean superior cost-efficiency when it comes to ensuring that different types of biodiesel meet the low-temperature performance standards of current fuel specifications.

The cold: a challenge for biodiesel

As liquid biodiesel is cooled, the components with a higher melting point begin to crystallize and come out of the solution. Initially, they form small crystals, which make the fuel look hazy to the naked eye. The temperature at which this first occurs is called the Cloud Point (CP). Continued cooling causes the crystals to grow into plate and needle structures that increase the viscosity of the biodiesel. When these plate and needle structures become sufficiently large; however, they can cause filter plugging, with the temperature at which this occurs being the Cold Filter Plugging Point (CFPP).

With further cooling, the crystals will continue to grow and form a three-dimensional lattice structure, which traps and immobilizes the biodiesel components that are still in the liquid phase. The lowest temperature at which fuel is still flowing is known as the Pour Point (PP). CP, CFPP and PP can be very close together in the untreated Biodiesel.

When the fuel is stored at a temperature between its Cloud Point and its Pour Point and the crystallization process is left undisturbed, waxy structures can settle out as a visible lower layer with a more or less diffuse structure. This wax formation and sedimentation process can be a source of extreme handling problems during storage and transport, but can be lessened in severity, or even eliminated, with the use of Cold Flow Improvers.

VISCOPLEX® CFIs: trademark of leading solutions

The operating principle of tailored VISCOPLEX® CFIs is based on its ability to nucleate and to co-crystallize on the edges of the growing crystal plates, thereby effectively blocking the continued growth of the individual crystal. The result is smaller crystals that more easily pass filters and that are less able to form the three-dimensional gel structures. The impact on the flow properties at cold temperatures: a drastic improvement in CFPP, PP and Filterability. Also the CP can be reduced by up to 6°C in FAME blends.





Worldwide expertise: the security of a global player

Evonik Oil Additives is the global leader in improving the cold flow properties of a wide range of petroleum and natural oil-based fuels and lubricants.

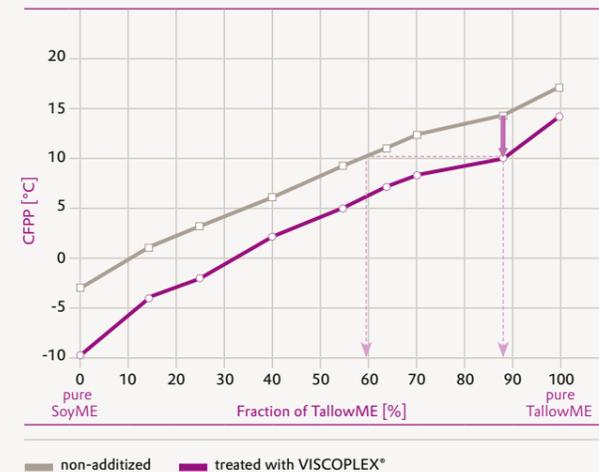
Under the trademark of VISCOPLEX®, we develop, produce and market viscosity index improvers, pour point depressants, dewaxing aids for refineries and special Cold Flow Improvers for biodiesel. We also support you with tailor-made products and services that meet your critical and specific demands for effective and economical solutions – worldwide.

Backed by highly trained experts and state-of-the-art technology centers in North America, Europe and Asia, we have 60 years of expertise, and proprietary polymer technology produced by a worldwide manufacturing network to guarantee you the quality in product, supply and availability that you expect from a global market leader.

To obtain a sample, find your local Evonik Oil Additives contact at www.evonik.com/oil-additives.

Cost Optimization with VISCOPLEX® CFI

Cost Saving with VISCOPLEX® in TME-SME Blends (Txx)



Increasing the Value of FAMES by Blending and Additization:

Focus on Biodiesel with CFPP = +10°C: Less expensive TME can be blended in higher proportions by use of VISCOPLEX® CFI.

The use of VISCOPLEX® CFIs has often proven more economical than other means for meeting the necessary CFPP requirements. In FAME-type blends, the use of VISCOPLEX® CFIs, if correctly selected, will reduce the quantity of costly FAMES. In most cases, the savings in the cost of FAMES more than pays for the cost of the Cold Flow Improver.

Contact us to discuss our experience with blends of soybean with animal tallow or rapeseed.

VISCOPLEX® Improves Cold Storage of Biodiesel

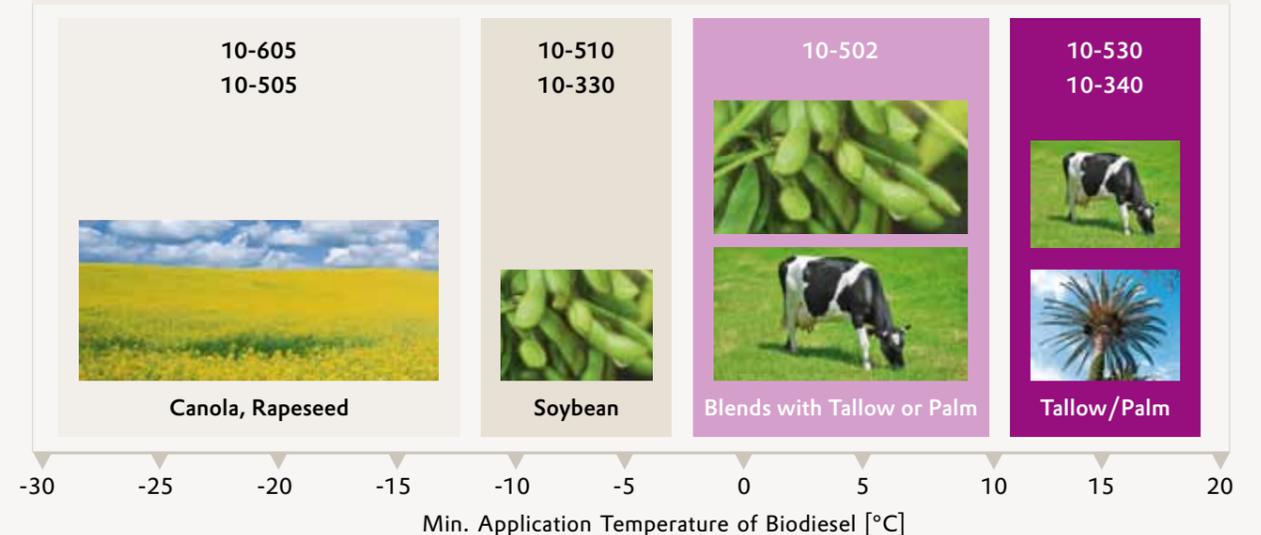
Biodiesel Samples Stored at -5 (Soy) and +3°C (T25) for 72 hours

Fuel	Soy ME*			T25 (75% SoyME + 25% TallowME)*		
	CP [°C]	CFPP [°C]	picture	CP [°C]	CFPP [°C]	picture
untreated	-2	-3		9	3	
+ VISCOPLEX®	-5	-9		3	-2	

*ME = Methyl Ester

VISCOPLEX® 10-series – Our Biodiesel CFI Portfolio

Optimal Solutions for all Temperatures





Special polyamide 12 compound

Clearing the way for the new fuel generation

Currently, B100-grade biodiesel may be used only if manufacturers expressly designate their vehicles as being compatible with this pure form of biodiesel. There's a good reason for this restriction. The solvent nature of certain chemical properties in biofuel can damage plastic and rubber components in the engine and fuel systems. All current tests have proven the aging resistance of special polyamide 12 compounds designed specifically for the automotive fuel systems of engines compatible with biodiesel blends based on rapeseed methyl esters.



VESTAMID®: the brand of choice for highly stable line systems

Polyamide 12 compounds from Evonik are synonymous with quality in the automotive and supplier industries. Marketed under the VESTAMID® brand, they've been the preferred choice for fuel line applications at renowned manufacturers for over 30 years.

VESTAMID® owes its status as the most popular polyamide 12 compound in the automotive industry to the consistently high level of quality, as well as such factors as excellent service, reliable delivery, and innovative solutions.

The most recent examples in the product family, VESTAMID® LX9008 and LX9013, have proven outstanding when used with RME biodiesel blends. As shown in tests according to the tough SAE J2260 standards in the US, this compound designed for the new diesel engine generations with common-rail or pump-nozzle systems is not only more resistant to aging under higher pressures and constant operating temperatures of 125°C, but also significantly more resistant to the free radicals that form in biofuels and can lead to a break-up of polymer chains.

Service: creating the competitive edge

With VESTAMID® LX9008 and LX9013, Evonik delivers clear competitive advantages, including technical superiority and significantly higher cost-effectiveness compared, for instance, to vulcanized elastomer compounds.

In addition, Evonik provides a modified VESTAMID® grade for an especially developed two-layer fuel line system called MLT 7040 (Multi-Layer Tube). Its conductive inner layer consists of a barrier material and, among others, protects the outer polymer against possibly aggressive substances in different biofuels.

Time and again, our strong focus on innovative solutions delivers a competitive advantage for our customers. Approximately 6% of sales of the High Performance Polymers Business Line goes back into research and development. No fewer than one-fifth of the roughly 1,000 people here work on developing new products and optimizing standard products, for current and coming generations of automobiles.

Ultimately, our approach to service translates into a competitive advantage for our customers – as does our proximity to where the rubber meets the road. It comes from working closely together with suppliers, systems developers, and automotive manufacturers.

Together, we exchange news and views and trends in compound development, testing technology, and legislation. Together we tailor special polyamide 12 compound to special applications, we design and define molds and tools, we keep manufacturing-technology personnel up to speed, and we develop new testing methods. More often than not, our processes eventually become industry standards. Our commitment to establishing standards gives you the assurance of quick reaction to change.



Process Technology & Engineering

Specialists for technology needs

As a global operator and the worldwide leader in specialty chemicals, Evonik draws on a wealth of experience in process technology. We pool and network this knowledge in our Process Technology & Engineering unit.

Our services and solutions, often developed jointly with research institutes and universities, form the basis for developing new technologies, methods and processes – as well as for further process and cost optimization. We support our business units to achieve their goals in the biodiesel field - from solving problems in biodiesel production all the way to cost-effective capacity expansion for the growing biofuel market.

Process Technology: the know-how for improving plant and equipment efficiency

Process optimization is a key aspect of our work in the biodiesel field. We help to make existing biodiesel facilities more cost-effective and more productive. Our competency areas cover the use of new oils and the optimization of existing reaction and separation stages in the biodiesel process as well as eliminating bottlenecks in existing plants to achieve 20 to 30% capacity gains.

Throughout these projects we support our business units with interdisciplinary teams that cover all the bases, from solution development and pre-selection to testing in our laboratories or pilot plants – all the way to successful large-scale implementation.

Engineering: international experience in plant design and construction

The core competency of Engineering lies in the planning and construction of production plants – in Germany and abroad. In the field of biodiesel, we focus on optimization measures such as eliminating bottlenecks. Our range of services for our business units includes:

- Project management, including quality, cost and schedule control
- Planning, including feasibility studies, basic and detail engineering
- Specialized services, from equipment technology to production logistics
- Construction and assembly management, and
- Operational support and training of personnel

Qualified and professional engineers and technicians, experienced in project and plant management, will deliver these services. That's why our customers can be sure that project objectives will be achieved to their satisfaction.

Certifications

The promise of quality – in writing

Total Quality is the connective tissue that runs through all our activities at Evonik. This applies to all our sites around the world, and all our business units. From raw material selection to production to delivery, the entire manufacturing process for our special solutions for biodiesel is reverse integrated.

Quality assurance is thus the responsibility of each business unit – and the best guarantee for consistent quality, homogeneous processes, and product properties, as well as excellent delivery reliability. We'll give it to you in writing.



Management-Systems

	ISO 9001 Quality Management System	ISO 14001 Environmental Management System	ISO / TS 169-49:2002 Quality Management System	EMAS European Environmental Management System	Kosher Certification
Alkoxides Nieder-kassel-Lülsdorf (G)	•	•		•	•
Cold Flow Improvers worldwide	•	•			
Defoamers Essen (G)	•	•			
Special Polyamide 12 Marl (G)	•	•	•		

Confidence in our products and the ability to deliver on our promise starts with the relationship between people. That's why you'll have one main contact for each specialized area, one who not only knows the biodiesel market inside and out, but also understands your needs and the requirements of your industry down to the smallest detail.

With product knowledge and experience, your contact is there to support you in any and all issues you deal with when it comes to biodiesel and implementing our solutions.

Alkoxides:

Michael Markolwitz

PHONE +49 2208 69-571

FAX +49 2208 69-640

michael.markolwitz@evonik.com

Defoamers:

Dirk Steinbeck

PHONE +49 201 173-1655

FAX +49 201 173-1990

dirk.steinbeck@evonik.com

Cold Flow Improvers:

Dr. Frank-Olaf Mähling

PHONE +49 6151 18-4160

FAX +49 6151 18-4100

frank-olaf.maehling@evonik.com

Special Polyamide 12 Compounds:

Dr. Ursula Keil

PHONE +49 2365 49-9878

FAX +49 2365 49-809878

ursula.keil@evonik.com

Process Technology & Engineering:

Dr. Mirko Michel

PHONE +49 2365 49-4651

FAX +49 2365 49-804651

mirko.michel@evonik.com

Disclaimer

This information and all technical and other advice are based on Evonik's present knowledge and experience. However, Evonik assumes no liability for such information or advice, including the extent to which such information or advice may relate to third party intellectual property rights. Evonik reserves the right to make any changes to information or advice at any time, without prior or subsequent notice. EVONIK DISCLAIMS ALL REPRESENTATIONS AND WARRANTIES, WHETHER EXPRESS OR IMPLIED, AND SHALL HAVE NO LIABILITY FOR, MERCHANTABILITY OF THE PRODUCT OR ITS FITNESS FOR A PARTICULAR PURPOSE (EVEN IF EVONIK IS AWARE OF SUCH PURPOSE), OR OTHERWISE.

EVONIK SHALL NOT BE RESPONSIBLE FOR CONSEQUENTIAL, INDIRECT OR INCIDENTAL DAMAGES (INCLUDING LOSS OF PROFITS) OF ANY KIND. It is the customer's sole responsibility to arrange for inspection and testing of all products by qualified experts. Reference to trade names used by other companies is neither a recommendation nor an endorsement of the corresponding product, and does not imply that similar products could not be used.

(Status: September 2008)



EVONIK
INDUSTRIES

Evonik Industries AG

Rellinghauser Straße 1-11

45128 Essen

Germany

www.evonik.com

Evonik. Power to create.