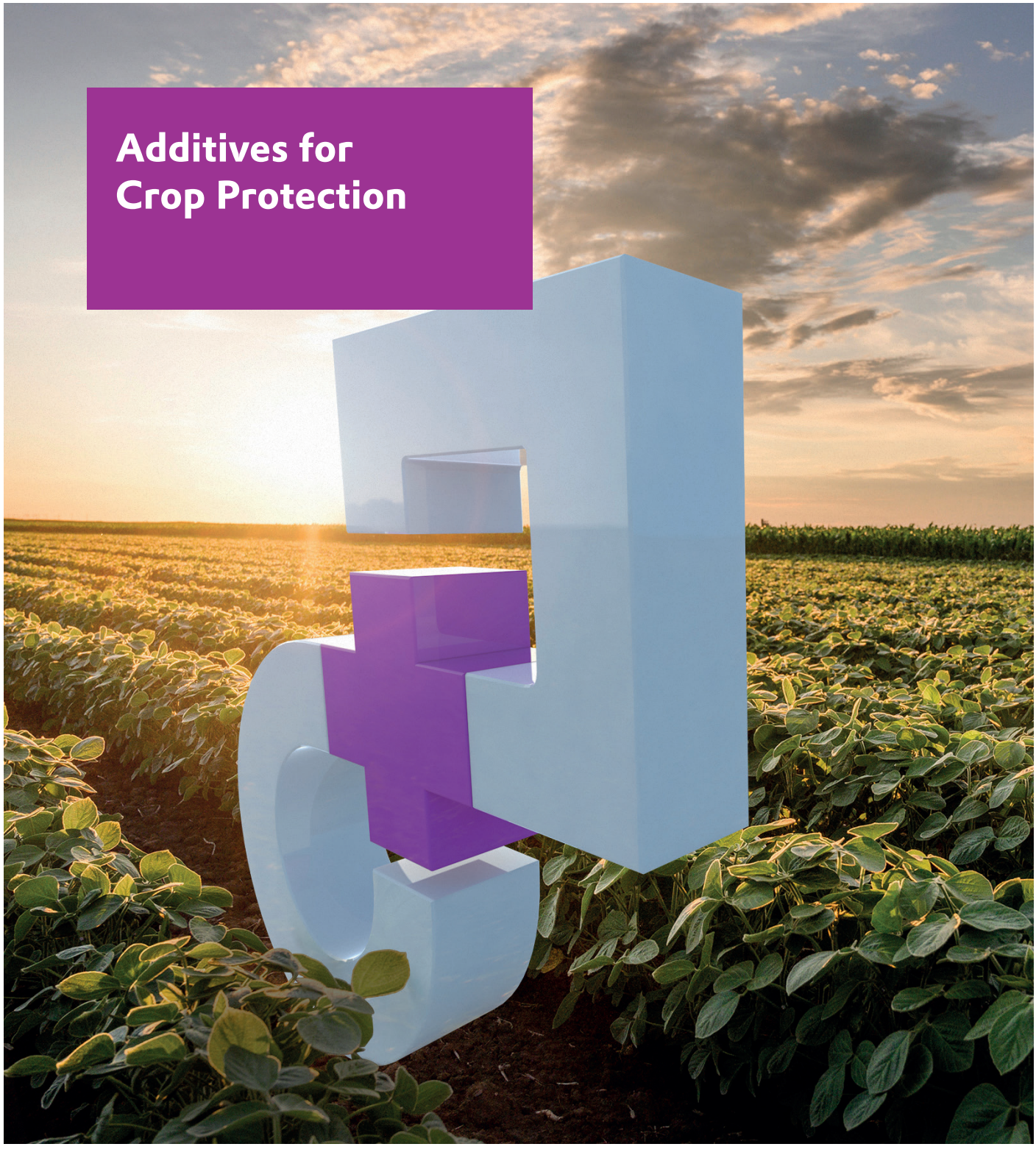
Additives for Crop Protection



EVONIK
Leading Beyond Chemistry

Face-to-Face Performance

OUR GLOBAL AGRO TEAM WILL ASSIST WITH:

- Providing guidance on the functionality, selection and optimal use of Evonik's products
- Developing guideline formulations
- Offering solutions based on a novel package of products and expertise
- Innovative developments for future challenges
- Utilizing our wide network of contacts to Evonik internal and external agricultural experts
- Creating long-term relationships based on trust

BREAK-THRU®
Technology for Agriculture

Evonik Agriculture Network

Other solutions, services and products for the agriculture market are offered by other departments of Evonik. From crop-protection agents, fertilizers, pesticides, anti-caking, anti-fouling and soil-conditioners to disinfection and aeration agents – the application fields of the Evonik products and com-petencies are diverse. Please follow the link for further information.

www.evonik.com/break-thru

VIDEO DEMONSTRATING THE ABILITY OF OUR TRISILOXANE SUPER-SPREADERS TO WET PLANTS AND OTHER HYDROPHOBIC SURFACES.

SPREADERS AND PENETRANTS

BREAK-THRU®

Both BREAK-THRU® Spreaders and Penetrants decrease the surface tension of pesticide formulations and thereby reduce the tendency of spray droplets to bounce off plant foliage. This effect allows for better deposition and retention on plant surfaces and maximizes the performance of agricultural chemicals. The BREAK-THRU® portfolio of Spreaders and Penetrants includes siloxane based polyethers and more recently biodegradable and solid trisiloxanes and biobased polyglycerolesters and sophorolipids.

Owing to their ultra low static surface tensions, BREAK-THRU® Super Spreaders provide superior spray coverage. They are unique among surfactants in their ability to impart phenomenal spreading characteristics to formulations. These products can also be instrumental in enabling cuticular penetration and in some cases stomatal flooding. As a consequence these surfactants help reduce the spray volume required for a particular pesticide application, and they allow for better targeting and increased pesticide uptake.

While organo modified siloxanes are synonymous with super spreadering, Evonik has designed variants of this chemistry to produce similar static surface tensions, but without appreciable spreading to behave mainly as a penetrant. Quick penetration can translate into rainfastness with many systemic pesticides as delivery of the pesticide into the plant has been accelerated and a later rainfall cannot wash it from the plant's surface.

BREAK-THRU® SP stands for Sticker Penetrant. The BREAK-THRU® SP products improve the deposition and retention of the agrochemical sprays and facilitate the uptake of the pesticide. At the same time they meet today´s requirements for product safety, environmentally friendliness and convenience of handling. BREAK-THRU® SP products are outstanding with reference to their low foam tendencies.

BREAK-THRU® SF stands for Spreader manufactured by fermentation. BREAK-THRU® SF 420 is a 100% biobased spreader improving wetting and adhesion of plant protection products. In addition it also provides dispersing properties for copper products. The low foaming product is considered for organic farming.

Benefits of BREAK-THRU® Spreaders and Penetrants:

- Improved spray deposition
- Increased spreading
- Improved penetration and rainfastness
- Improved retention
- Alternative to tallow amine ethoxylates or alkylphenol ethoxylates
- Reduced spray volume
- Increased pesticide efficacy
- Biodegradable, solid and OMRI listed trisiloxanes
- Biobased spreaders and spreaders made by fermentation

Properties of BREAK-THRU® Spreaders and Penetrants

PRODUCT	CHEMICAL DESCRIPTION	MODE OF ACTION	STABLE WITHIN pH RANGE	STATIC SURFACE TENSION [mN/m] IN X% WATER	APPLICATION PROPERTIES
BREAK-THRU® S 200	Organo modified Trisiloxane	Super Spreader	6–8	22 (0.1%)	Excellent adhesion and retention, esp. for aqueous formulations with a high salt content, excellent emulsifying properties in methylated seed oils
BREAK-THRU® S 240	Organo modified Trisiloxane	Super Spreader	6–8	22 (0.1%)	Excellent adhesion and retention, esp. for liquid formulations
BREAK-THRU® S 279	Organo modified Trisiloxane	Super Spreader	6–8	21 (0.1%)	Excellent adhesion and retention, for liquid and solid (WDG) formulations
BREAK-THRU® S 301	Organo modified Trisiloxane	Super Spreader	6–8	22 (0.1%)	Excellent adhesion and retention
BREAK-THRU® SD 260	Organo modified Trisiloxane/ PEG 6000	Super Spreader	6–8	22 (0.1%)	Excellent adhesion and retention, esp. suited for enhancing the biological performance of (semi-) systemic products for solid formulations, trisiloxane on a water soluble solid carrier with humectant properties
BREAK-THRU® S 233	Organo modified Trisiloxane	Spreader Pene-trant	6–8	23 (0.1%)	Excellent adhesion, retention and penetration, reduces the amount of particles prone to drift, low foam tendency
BREAK-THRU® SP 133	Polyglycerol-ester	Sticker Pene-trant	4–9	29 (0.1%)	Improved wetting and adhesion, dispersing properties for copper products, ~45% active content in water, low foaming tendency
BREAK-THRU® SF 420	Sophorolipid	Spreader	4–9	~30 (0.2%)	Enhanced deposition due to low drift tendency, esp. good for monocots with vertical leaves, very low foam tendency
BREAK-THRU® VIBRANT	Polyether	Deposition Aid	3–12	28[2)] (0.1%)	

Please refer to our leaflet Overview of BREAK-THRU®, SURFYNOL® and TOMADOL® products for information regarding labelling, biobased and/or biodegradable material and OMRI listing status of our products.

[1)] Very low dynamic surface tension of 31 mN/m measured at 30 ms

SURFYNOL®

SURFYNOL® non foaming surfactants are especially noted for their ability to lower the dynamic surface tension of aqueous solutions. They improve the degree of surface coverage and penetration of a pesticide.

SURFYNOL® 104 series surfactants are Gemini functional wetting agents synthesized to provide high dynamic surface activity and therefore accelerated wetting of hydrophobic surfaces. The unique chemical structures allow these products to provide multifunctional properties such as surface tension reduction, foam control, and stabilization.

SURFYNOL® 400 surfactant series are wetting agents providing compatibility in an array of agricultural chemical applications.

Benefits of SURFYNOL® wetters

- High dynamic surface activity
- Thermal and chemical stability over a broad range of conditions
- Reduce microfoam in spray-applied systems
- Enhance leaf and soil penetration while improving bloom and stability in formulations
- Very good for difficult to wet surfaces and monocots
- Outstanding low foam formation
- OMRI listed

Properties of SURFYNOL® and TEGO® wetters

PRODUCT	CHEMICAL DESCRIPTION	MODE OF ACTION	STABLE WITHIN PH RANGE	DYNAMIC SURFACE TENSION AT 0.1 wt %, 6 b/s (mN/m)	APPLICATION PROPERTIES
SURFYNOL® 104	Acetylenic diol	Wetter	4–10	36	Enhance leaf and soil penetration while improving bloom and stability in formulations
SURFYNOL® 104 PG 50	Acetylenic diol	Wetter	4–10	40.2	Enhance leaf and soil penetration while improving bloom and stability in formulations
SURFYNOL® 440	Ethoxylated Acetylenic diol, average degree of ethoxylation 3.8 moles	Wetter	4–10	35.3	Low foaming wetting agent
SURFYNOL® 485	Ethoxylated Acetylenic diol, average degree of ethoxylation 22–23 moles	Wetter	4–10	53	Low foaming wetting agent
TEGO® SML 20	Polyoxyethylene-(20)-sorbitan monolaurate	Wetter	5–9	32*	Compatible with anionic, cationic and amphoteric surfactants. As co-emulsifier it shows synergistic effect with other surfactants.

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*Static surface tension (mN/m) 0.5% in water

OIL ENHANCERS

Mode of action:

- Improved spreading
- Improved penetration
- Inhibits crystallization of larger agglomerates

BENEFITS OF BREAK-THRU® OIL ENHANCERS:

- Improved coverage and penetration for greater efficacy
- Effective at low concentrations
- Low toxicity and ecotoxicity
- Soluble in plant or petroleum based oils
- Safe on crops at the intended use rates
- Generate little to no foam

Properties of BREAK-THRU® Oil Enhancers

PRODUCT	CHEMICAL DESCRIPTION	APPLICATION PROPERTIES
BREAK-THRU® OE 440	Organo modified Siloxane	Improved penetration of actives especially in formulations based on vegetable oils
BREAK-THRU® OE 444	Organo modified Siloxane	Improved penetration of actives especially in formulations based on paraffinic oils
BREAK-THRU® OE 446	Organo modified Siloxane	Improved penetration of actives in oil and water based formulations, stable within a pH range of 3–11, spreader esp. for methylated vegetable oils, antidust agent in WDG & for seeds treatments

Please refer to our leaflet Overview of BREAK-THRU®, SURFYNOL® and TOMADOL® products for information regarding labelling, biobased and/or biodegradable material and OMRI listing status of our products.

Many pesticides exhibit limited water solubility, so mineral and vegetable oils often serve as the carriers to deliver these actives to plants or pests. BREAK-THRU® Oil Enhancer are unique additives designed to improve the performance of oil based crop protection formulations. They work by lowering the surface tension of oils and solvents, thus enabling faster and more complete leaf coverage and penetration into the plant. Added in small amounts, they enhance the efficacy of oil based pesticides formulations. As oil preferences and compositions vary globally, the BREAK-THRU® OE comprise a series of products designed for a broad spectrum of oils and formulation types. These products are suitable for use in EC, EW, SC, WDG and OD crop protection formulations as well as in crop and mineral oil.

BREAK-THRU® OE 446 is easy to apply and versatile as it is both an oil and water soluble adjuvant. BREAK-THRU® OE 446 is particularly suitable for formulations based on methylated vegetable oils and some solvents. As it is also water soluble, it can be used in aqueous formulations. BREAK-THRU® OE 446 has been found to prevent agglomeration of solid particles and inhibit their crystallization. It can be also applied in seed treatments to reduce abrasion and dust creation.

ANTIFOAMS

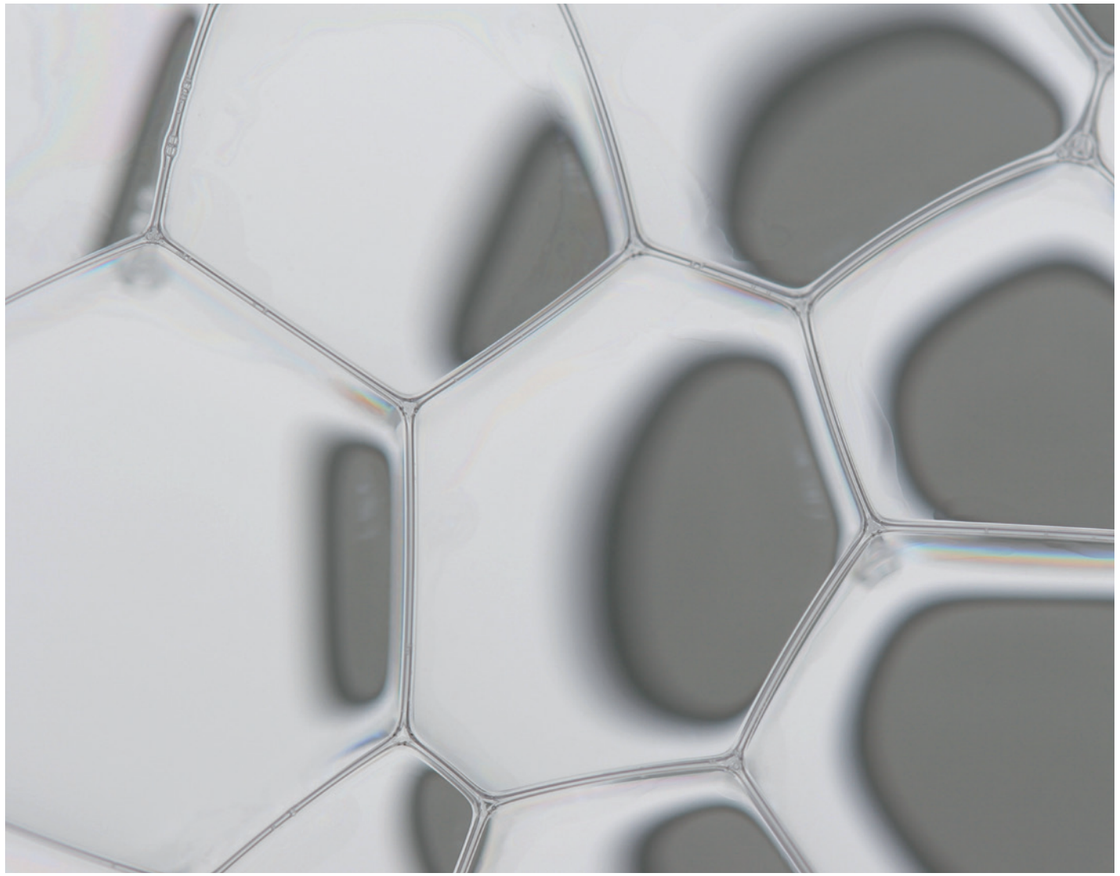
Benefits of BREAK-THRU® Antifoams:

- Highly efficient
- Highly compatible with concentrates
- Minimum influence on shelf life of dilutions
- Suitable for water and oil based formulations
- Benign toxicological profile

In agrochemical formulations, a variaty of surface active chemistries are used as wetting agents, emulsifiers, dispersants, compatibilizers and even solvents. Many of them tend to generate and stabilize foam.

Foam formation can occur during manufacture and packaging of formulations, but also during field application. Foaming poses serious problems as it interferes with efficient filling of containers, increases processing times, and leads to possible loss of product due to overflow. BREAK-THRU® Antifoams are added directly into the agricultural formulation to allow an easy and safe handling of the formulations.

BREAK-THRU® AF products have a benign toxicological profile. These siloxane products are modified with organic groups and are tailor-made to overcome incompatibility, while maintaining the efficiency and low dose rates typical of silicone oils. BREAK-THRU® AF offers long term stability and superior compatibility in both water and oil based formulations. Since individual formulations contain different active ingredients, solvents and surfactants, a universal solution to foaming issues does not exist. BREAK-THRU® antifoam agents are very robust in their performance and are used in a variety of applications.



Properties of BREAK-THRU® Antifoams

PRODUCT	CHEMICAL BASE	ACTIVE CONTENT	VISCOSITY @ 25 °C [mPas]	APPLICATION PROPERTIES
BREAK-THRU® AF 5503	Organo modified siloxane	100%	400–600	Especially for SL formulations, easy-handling due to self emulsifiability, high tolerance to salts
BREAK-THRU® AF 9902	Organo modified siloxane with silica	100%	500–1000	For oil-/solvent-based formulations
BREAK-THRU® AF 9903	Organo modified siloxane with silica	100%	500–1500	Especially for water-based formulations, easy-handling due to self emulsifiability, high tolerance to salts

Please refer to our leaflet Overview of BREAK-THRU®, SURFYNOL® and TOMADOL® products for information regarding labelling, biobased and/or biodegradable material and OMRI listing status of our products.

DISPERSING AGENTS

BENEFITS OF BREAK-THRU® DISPERSING AGENTS:

- Improved stabilization
- Better biological efficacy
- Show good emulsifying properties
- No need for co-wetting agents in the dispersion process
- Low foaming
- Improved milling efficiency
- Benign toxicological profile

Properties of BREAK-THRU® Dispersing Agents

PRODUCT	CHEMICAL DESCRIPTION	FOAM TENDENCY	ACTIVE CONTENT	APPLICATION PROPERTIES
BREAK-THRU® DA 646	Non-ionic modified polyether	low	100%	Particularly effective in OD formulations, emulsifier for methylated vegetable oil and aromatic solvents, for sensitive active ingredients
BREAK-THRU® DA 647	Non-ionic modified polyether	low	100%	Particularly effective in SC and SE formulations, for sensitive active ingredients, emulsifier for aromatic solvents and methylated vegetable oil
BREAK-THRU® DA 655	Polyether phosphate	low	100%	Particularly effective in OD formulations, emulsifier for methylated seed oil and aromatic solvents
BREAK-THRU® DA 675	Non-ionic organically modified polymer	low	40%	Particularly effective in SC formulations, for sensitive active ingredients

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BREAK-THRU® DA products are dispersing agents which ease the incorporation of solid active ingredients in liquid formulations and prevent their settling and re-agglomeration. The dispersing agents are adsorbed onto the surface of the particles leading to wetting of the particles and coverage of the surface. By adsorbing on newly created surfaces during milling, they reduce interactions and re-agglomeration of the particles. This increases milling efficiency. The resulting small particle size enables a better pesticide uptake. BREAK-THRU® DA products finely disperse the particles which leads to a long term stability of the formulations.

The benefits are a higher biological efficacy and enhanced storage stability of the formulations, even under extreme conditions.

BREAK-THRU® DA products can be applied in SC and OD formulations. They promote stable dispersions without settling and syneresis in the dispersing medium. BREAK-THRU® DA products are multi-functional additives often providing also emulsification properties useful in OD formulations. In addition they have benign toxicological profiles.

EMULSIFIERS

BREAK-THRU® EM, for excellent emulsification

BREAK-THRU® Emulsifiers include primary and secondary emulsifiers that are based on renewable resources such as sorbitol, fatty acids and glycerol.

BREAK-THRU® EM products are non-ionic, hydrophilic or lipophilic organic surfactants used for the preparation and stabilization of both oil-in-water and water-in-oil emulsions. BREAK-THRU® EM products balance hydrophilic and lipophilic properties to allow for adjustment to the needs of different applications. To emulsify a specific oil, the precisely adjusted HLB[1)] values of BREAK-THRU® EM products are needed. The required HLB value can be adjusted by selected blending. BREAK-THRU® EM products also provide dispersing, solubilizing and wetting properties.

The TOMADOL® ethoxylated alcohols surfactants have a dual function in formulations. They increase the blooming effect of formulations in water and enhance the wetting of hydrophobic surfaces.

TOMADOL® 1-5 at 0.1% promotes excellent wetting of hydrophobic substrates by reducing the static surface tension to 26 mN/m. Also, at 0.015% in water the contact angle measures 18°. TOMADOL® 1-5 is a good emulsifier for aromatic and dearomatized hydrocarbon solvents. It is readily biodegradable.

Benefits of BREAK-THRU® Emulsifiers:

- Excellent emulsifying and stabilizing properties with low treat rates
- Excellent soluble products for vegetable and synthetic oils
- Derived from renewable resources
- No skin or eye irritation, benign toxicological classification

Properties of BREAK-THRU® Emulsifiers

PRODUCT	CHEMICAL BASE	HLB[1)]	FORM	APPLICATION RECOMMENDATIONS
BREAK-THRU® EM V 20	PEG[2)] (20) Glyceryl Oleoricinoleate	8.4	liquid	for vegetable oil – also for naturally derived pesticidal oils
TEGO® STO 85 V	PEG[2)] (20) sorbitan trioleate	11.0	liquid	for mineral oil
TEGIN® OV	Glycerol mono/dioleate	3.3	paste, melting point ~30°C	as co-emulsifier for BREAK-THRU® EM V 20
BREAK-THRU® EM O 5	Glycerol mono/dioleate	5.5	liquid	as co-emulsifier for BREAK-THRU® EM V 20

Properties of TOMADOL® Emulsifiers

PRODUCT	CHEMICAL BASE	HLB[1)]	FORM	APPLICATION RECOMMENDATIONS
TOMADOL® 1-5	Alcohol ethoxylated	11.2	liquid	For aromatic and dearomatized hydrocarbon solvents

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[1)] HLB = hydrophilic-lipophilic-balance [2)] Polyethyleneglycol

FORMULATIONS AND FIELD PERFORMANCE

The BREAK-THRU® product portfolio in combination with the expertise of the technical service of Evonik enables our customers to differentiate their formulations in the market.

TECHNICAL EXPERTISE

Evonik has expertise in preparing solid and liquid formulations like OD, SC, EC, SL, WDG and WP and has the equipment to do so (e.g., Dyno®-Mill, SpeedMixer™, solid extruders). We test the quality, stability and foam properties of these formulations by established CIPAC (Collaborative international pesticides analytical council) methods. We have an in-depth understanding of the interfacial behavior of our products as evidenced by our testing equipment for the physico-chemical evaluations, e.g., Bubble Pressure Tensiometers (SITA and LAUDA), Pendant Drop Tensiometer (DATA PHYSICS), Turbiscan™ LAB, Beckman Coulter LS 230, Anton Paar Rheometer Physica MCR 301. Moreover with our spectroscopic equipment (e.g., Hitachi Scanning Electron Microscope, LEICA Confocal Laser Scanning Microscope) we are able to visualize the mode of action of our products. In addition we use our competence in agronomy to design and conduct glasshouse and field trials globally to evaluate the performance of our products and formulations.

EVONIK SERVICE

Our aim is to give you the ability to differentiate your formulation in the market. We not only offer superior agrochemical products, but also the service to develop guideline formulations in partnership with our customers. With customer supplied actives, we use our broad portfolio of high performance adjuvants and additives for In-Can applications to develop guide formulations. So please contact us to discuss your specific application.

EXAMPLES FOR FORMULATIONS AND THEIR FIELD PERFORMANCE

Two formulation recipes are shown here with our BREAK-THRU® products. The SC formulation is designed to deliver the active (Imidacloprid) in liquid formulation without solvent. To create a stable, effective and environmental friendly formulation we used our BREAK-THRU® DA 675 and BREAK-THRU® DA 647.

With both BREAK-THRU® Dispersing Agents we achieve excellent and stable formulations with good dispersibilities in water and with low foaming tendencies. In addition the formulations have excellent biological efficacies.

As shown in the chart below, the Imidacloprid 20% SC formulation prepared with BREAK-THRU® Dispersing Agent and Oil Enhancer afforded better efficacy than a commercial product. In a field test for control of cotton aphids the guideline formulation with reduced active ingredient content exceeded the effect of the commercial product at full rate.

OD formulations require unique dispersing agents and emulsifiers to suspend active components in oils. Our BREAK-THRU® Dispersing Agents ►►►

Imidacloprid 20% SC formulation

wt-%	INGREDIENT	FUNCTION
20.0	Imidacloprid	Active Ingredient
5.0	BREAK-THRU® DA 675 or BREAK-THRU® DA 647	Dispersing Agent
3.0	BREAK-THRU® OE 446	Oil Enhancer
0.3	Xanthan Gum	Thickener
0.1	Acticide MBS[2)]	Preservative
0.3	BREAK-THRU® AF 9903	Defoamer
71.3	Water	Solvent

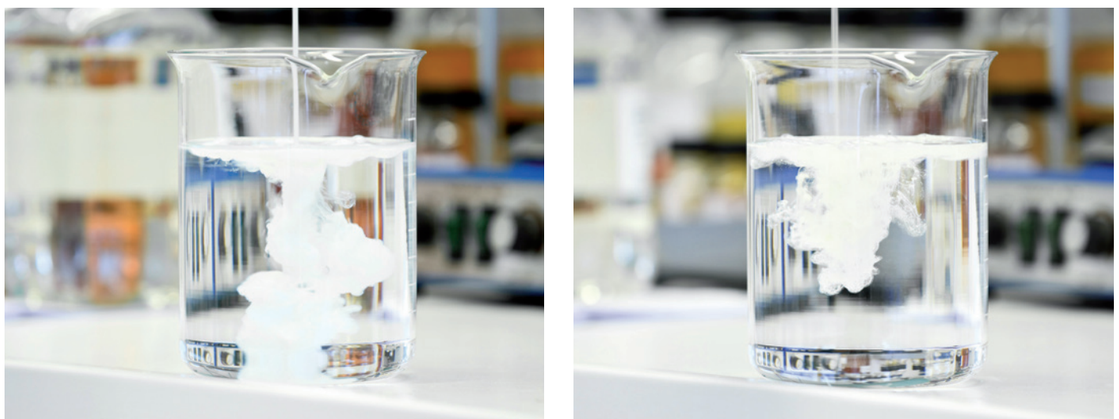
Nicosulfuron 45 g/L OD formulation

wt-%	INGREDIENT	FUNCTION
4.5	Nicosulfuron	Active Ingredient
5.0	BREAK-THRU® DA 646	Dispersing Agent
15.0	TEGO® STO 85 V	Emulsifier
3.0	BREAK-THRU® OE 446	Oil Enhancer
68.5	EXXSOLTM D 100[3)]	Solvent
4.0	AEROSIL® 200[1)]	Thickener

[1)] registered trademark of Evonik Resource Efficiency GmbH [2)] registered trademark of Thor GmbH [3)] registered trademark of ExxonMobil Chemical

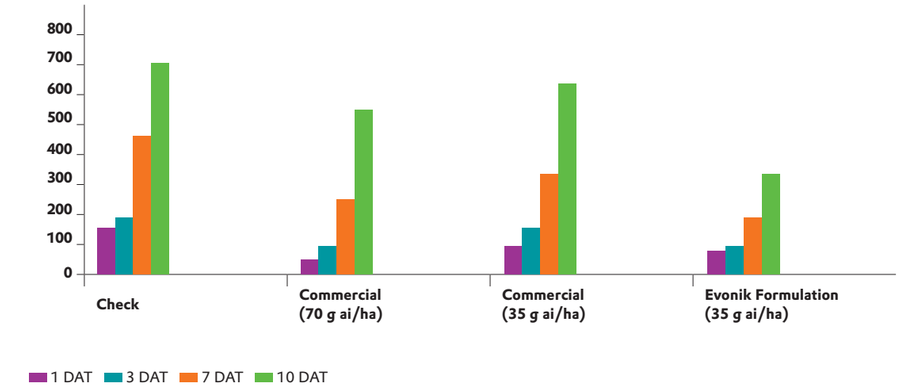
►►► support the fine milling of the solid particles. In addition our OD formulation benefits from Evonik AEROSIL® fumed silica which is an effective network builder in both mineral and natural oils. They lead to thixotrophic properties of the formulation and to an excellent stability of the formulation with extended shelf life.

Our example for a Nicosulfuron OD formulation proved to be a formulation with high stability and excellent dispersibility in water. The Nicosulfuron 45 g/L OD formulation prepared with BREAK-THRU® Dispersing Agent and Oil Enhancer afforded better efficacy than the commercial product in the glasshouse trial on Poa pratensis. Even at reduced active ingredient content results with the guideline formulation nearly matched performance with the higher dosage in the commercial product.

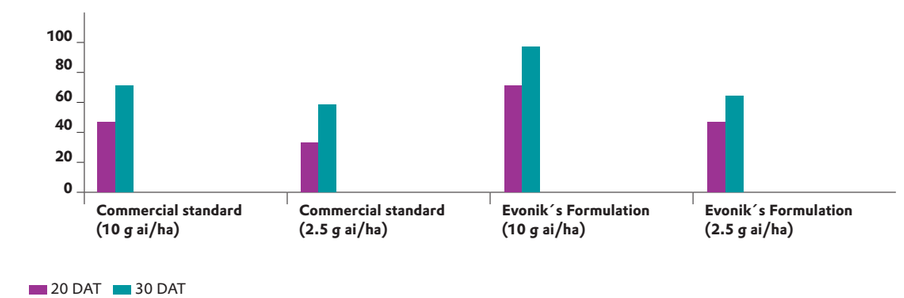


Emulsification behavior of the Evonik formulation (left) compared to a commercial standard (right)

RESULT OF FIELD TEST WITH IMIDACLOPRID 20% SC FORMULATION ON COTTON APHIDS
(number of aphids per 20 leaves / ai = active ingredient / DAT = day after treatment)



RESULT OF GLASSHOUSE TRIAL WITH NICOSULFURON 45 G/L OD FORMULATION ON POA PRATENSIS
(Efficacy in % / Spray volume 200 L/ha / ai = active ingredient / DAT = day after treatment)



Europe | Middle East | Africa

Evonik Operations GmbH
Goldschmidtstraße 100
45127 Essen
Germany
Phone +49 201 173-2665
Fax +49 201 173-1990
www.evonik.com

Asia | Pacific

Evonik Specialty Chemicals Co., Ltd.
55, Chundong Road
Xinzhuang Industry Park
Shanghai, 201108
PR China
Phone +86 21 6119-1125
Fax +86 21 6119-1406

The Americas

Evonik Corporation
7801 Whitepine Road
Richmond, VA 23237
USA
Phone +1 804 727-0700
Fax +1 804 727-0855

www.evonik.com/break-thru

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