



EXILVA® MICROFIBRILLATED CELLULOSE FROM BORREGAARD

SUSTAINABLE PLANT CARE WITH EXILVA®





WHAT IS EXILVA?

Borregaard's Exilva® Microfibrillated cellulose (MFC) is a sustainable, innovative, biobased and biodegradable material consisting of water suspended, non-soluble cellulose microfibril bundles designed for use in a broad range of aqueous and polar solvent based formulations. Exilva, CAS number 9004-34-6, consist of cellulose and water and is delivered biocide free. It is a problem solver for Crop Protection, Biocontrol, Plant Nutrition and Seed Treatments/Coatings.

MAIN USE:

- Improved formulation stability and workability over time
 - in a wide pH range,
 - and with high electrolyte content.
- Improved fertilizer compatibility of crop protection products
- Reduced dusting, improved abrasion resistance and improved germination of seed treatments, coatings and film coated seeds

SECONDARY EFFECTS:

- Uptake enhancement of actives
- Improved rain fastness

APPLICATIONS:

- Crop protection and adjuvants
- Plant nutrition and liquid fertilizers
- Seed treatments and coatings
- Biocontrol

REGULATORY:

Exilva is produced from sustainable, renewable and non-GMO cellulose of very high purity originating primarily from the Scandinavian forests. Toxicological assessments indicate that Exilva is physiologically inert and safe in use.

- 100 % Biobased
- Biodegradable
- Microplastic free
- REACH exempt
- Inert (EPA inert list)
- Toxic Substances Control Act (TSCA) compliant
- Listed in NZIoC / IECSC / ISHL / ENCS/ KECI Chemical inventory

FEATURES OF EXILVA

Exilva microfibrils form flexible network of fibrils with high surface area allowing efficient interactions with the surroundings. When Exilva is fully dispersed, the resulting formulations possess unique functionalities. They are structured pseudoplastic systems that can also show thixotropic behaviour in some cases. Exilva can function as a rheology modifier and thickener, a film former, an additive in seed treatments and coatings. It is an excellent structuring agent and a suspending agent for particles, pigments, capsules, actives and oil droplets.



BIOBASED AND BIODEGRADABLE ADDITIVE WITH MULTIPLE BENEFITS:

- Improved formulation stability
- Improved anti-settling of suspended particles and pigments
- Compatibiliser in high-ionic strength systems
- Improved spraying and anti-sagging properties
- Improved film forming properties
- Enhanced dry and wet strength (tensile strength) of coatings
- Safe and enhanced germination of seeds

CHARACTERISTICS OF EXILVA:

- Very high viscosity at rest
- Extreme shear thinning properties
- High and tunable yield stress (gel strength)
- Extreme high water retention value (WRV)
- Excellent film forming properties

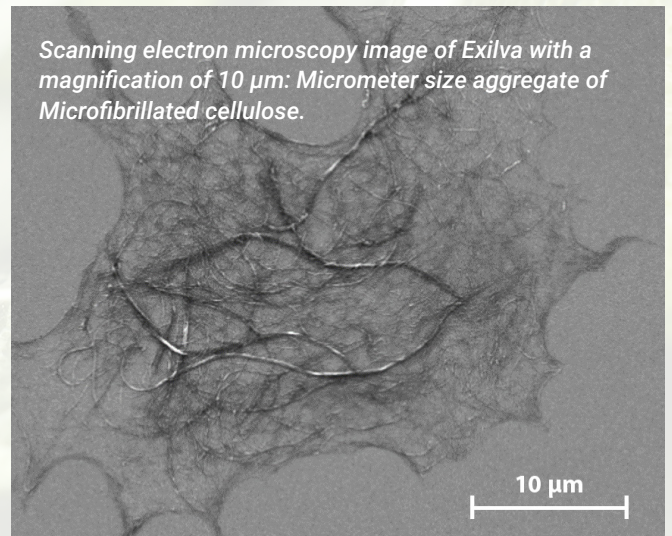
PHYSICAL PROPERTIES: White to off-white and opaque

FORMAT: Dispersion or paste

STORAGE: Should be stored in closed container protected from heat (< 25°C) and direct sunlight. Damaged if frozen.

SHELF-LIFE: Stored as advised, Exilva dispersion has a shelf-life of 24 months and Exilva paste a shelf-life of 18 months from date of production.

Scanning electron microscopy image of Exilva with a magnification of 10 µm: Micrometer size aggregate of Microfibrillated cellulose.



Exilva is available in two different concentrations:

- 2 wt% dispersion of MFC in water -> Exilva F 01-L
- 10 wt% paste of MFC with water -> Exilva F 01-V

HOW CELLULOSE FIBRILS CAN HELP WITH FORMULATION CHALLENGES

PROBLEM SOLVER

RHEOLOGY CONTROL AGENT:

The cellulose fibrils form hydrogen bonding with physical entanglements in the formulations leading to high viscosity at rest and extremely shear thinning profile of the material.

It therefore enables improving shelf-life stability of formulations while maintaining flow, pourability and workability.

STRUCTURING AGENT:

Exilva has a high and tunable yield stress and gel strength. It enables structuring of high solid content formulations and capsules.

ROBUST AND WORLD-CLASS COMPATIBLE:

Due to its world-class robustness and compatibility in wide pH ranges and high electrolyte content formulations, Exilva improves fertilizer compatibility of crop protection formulations.

It avoids gelling, precipitation and sedimentation of the crop protection when tank mixed with fertilizers.

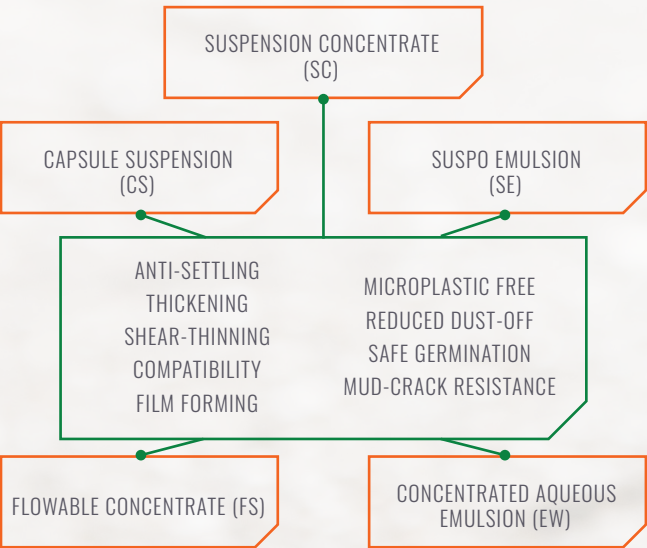
It provides the formulator a more flexible and robust approach when formulating fertilizers and nutrients with pesticides allowing for combinations of crop protection and plant nutrition chemistries.

TABLE 1: Yield stress of Exilva in a white pigment dispersions (70 wt% TiO₂), compared against other common rheology modifiers. Rheology modifiers used at 0.5 wt% active material. Yield stress measured at 25°C.

Description	Yield stress (Pa)	Storage modulus G' (Pa)
No rheology additive	–	–
Exilva	2.57	1 800
Fumed silica	0.54	336
Clay platelets	1.43	801
Modified urea	0.66	365
Hydroxyethyl cellulose	1.46	910

FORMULATING WITH EXILVA

TARGET LIQUID FORMULATIONS:



WHEN TO ADD EXILVA:

- Early process step
- Aqueous or polar solvent phase
- Before or during milling when applicable

RECOMMENDED USE RATE:

- 0.3–0.5 wt% cellulose fibrils
- 3–5 wt% Exilva F 01-V (high shear dispersion required)
- 15–20 wt% Exilva F 01-L (low shear dispersion possible)

EXILVA MAINTAINS ITS PERFORMANCE:

Exilva can help overcome the typical limitations of conventional rheology additives:

- At extreme pH (1 to 13)
- With high electrolyte content
- With temperature change
- With different surfactants

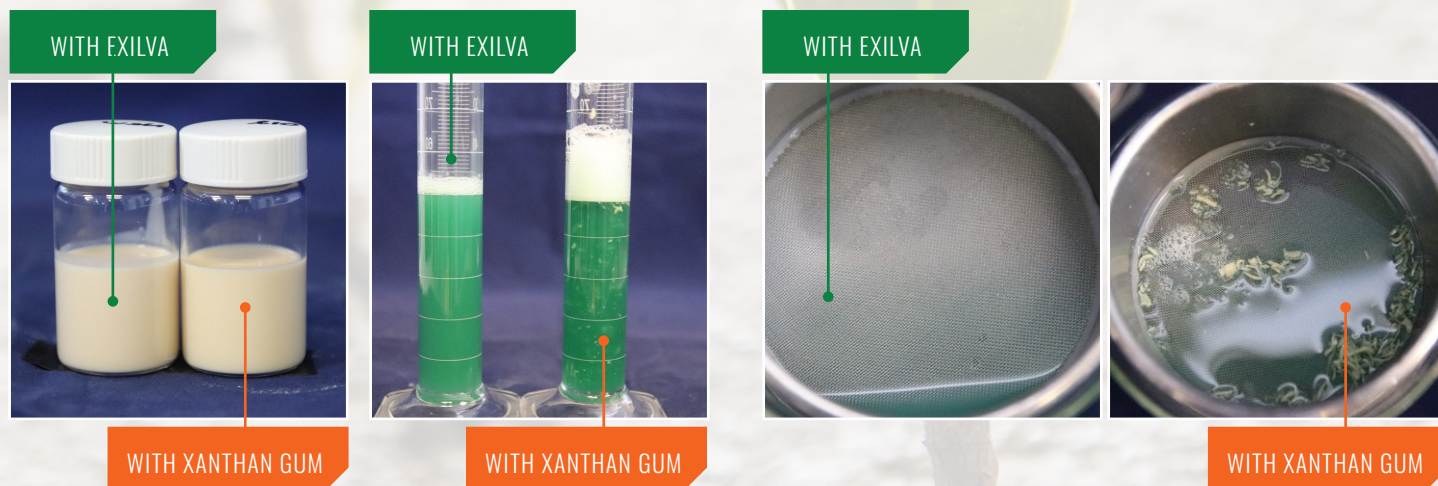
Exilva has excellent microbiological stability.

EXAMPLE

EXILVA MFC USED TO IMPROVE FERTILIZER COMPATIBILITY OF A CROP PROTECTION FORMULATION

When a Capsule Suspension (CS) formulation of *Chlorethoxyfos* and *Bifenthrin* structured with Exilva was compared with the same formulation but structured with xanthan gum, the following observations were made:

- Frequency sweep on the two CS formulations show that both formulations have solid-like behavior at 0.5 % strain ($G' > G''$).
- **Upon mixing the CS formulation with the NPK liquid fertilizer 7-20-3:**
 - No precipitation or gelling was observed with the Exilva structured CS formulation
 - Precipitation was observed with the xanthan gum structured CS formulation
- **Upon filtering the blend of CS formulation and the NPK liquid fertilizer 7-20-3:**
 - Clean and non-clogged sieve/screen was observed with the Exilva structured CS formulation
 - Precipitate caused clogging of the sieve/screen with the xanthan gum structured CS formulation



Left: Capsule Suspension (CS) formulation of *Chlorethoxyfos* and *Bifenthrin* structured with Exilva or with xanthan gum. Right: Appearance of capsule suspensions after tank mixing with NPK liquid fertilizer 7-20-3.

Picture of screens after filtering the tank mix of the capsules suspensions and liquid fertilizer. No precipitates observed when Exilva is used.

KEY BENEFITS IN USE:

- Improved formulation stability over time
- Improved anti-settling properties of concentrates
- Reduced sedimentation of suspended solids and capsules
- Improved emulsion stability
- Improved workability, pourability and spraying of formulations
- No gelling or precipitation at extreme pH conditions or at high salt/electrolyte content
- Reduced to no clogging of screens or filters
- Improved temperature and shear stability of formulations

SEED COATINGS AND SEED TREATMENTS

In coating systems in general, Exilva has shown to have benefits and advantages in stabilizing the liquid formulation, improving its application and improving surface properties of the cured coating. Its robustness and compatibility allow for combinations of several chemistries, combinations of solids and solubles, and increase in amount of solids/actives in the formulation. Exilva could have one or more advantage in use.

Exilva leads to stronger and safer seed coatings. The unique and immediate response of the fibrils to the presence of water allow for safe and early seed germination. Even though the fibrils have good wet strength and do not dissolve in water, the fibrillar network shows immediate change in porosity, permeability and barrier properties.

WHAT TO LOOK FOR:

FORMULATION STABILITY

- Structuring of Flowable Concentrates
- Structuring of Liquid Seed Coats
- Stabilisation of pearls, pigments colours

IMPROVED SURFACE PROPERTIES:

- Reduced dusting
- Improved abrasion resistance
- Improved tensile strength
- Reduced cracking

IMPROVED PERFORMANCE:

- Early and safe seed germination

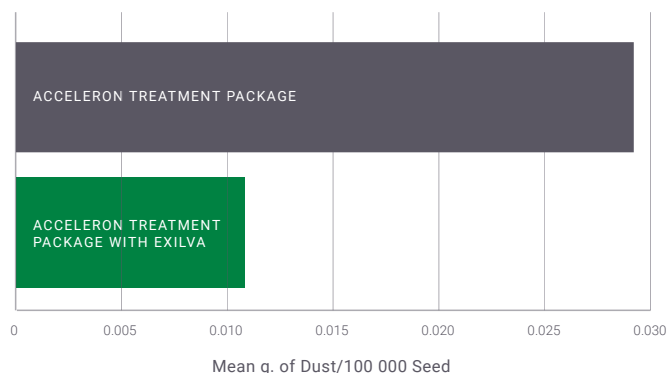


Soybeans coated without and with Exilva.

CASE STUDY: EFFECT OF ADDING EXILVA INTO A SOYBEAN SEED COATING

In a dust control study, Exilva showed around 60% reduced dusting of coated Soybean seeds and improved plantability without negatively affecting flowability of the seeds. An Acceleron treatment was tested on Soybean seeds with and without 0.3 wt% cellulose fibrils (of the total formulation volume). The treatment was applied on the seeds in a Hege batch treater bowl. The dusting was tested with a Heubach Dustmeter using 4 repetitions of 100 g.

Exilva offers a sustainable way to reduce the dust emissions of the coated seeds. At the same time, it has been proven that Exilva has a positive effect on plantability of the seeds with no negative effect on their flowability.



Average mass of the dust gathered on the filter in a dusting test for soybeans treated either with Acceleron treatment package or Acceleron treatment package and Exilva.



UNIQUE PROPERTIES OF EXILVA FILM

Exilva has excellent film forming properties: thin, translucent, strong films. The Exilva fibrillar network has good wet strength and does not dissolve in water. The network shows immediate change in porosity, permeability and barrier properties with humidity and water.

EXILVA AS AN ADDITIVE IN COATINGS IMPROVE SURFACE PROPERTIES

Reference with HEC (0.31 w%)
Cracking > 0.36 mm

EXTERIOR ACRYLIC PAINT – MUDCRACK RESISTANCE

- No "skin" formation during drying
- Non tacky surface during drying
- Exilva enables increased film thickness – reduction in required film layers
- Exilva provides film reinforcement through the fiber structure

Exilva (0.38 w%)
No Cracking, Pass 1.52 mm

APPENDIX: TECHNICAL DATA

RHEOLOGY

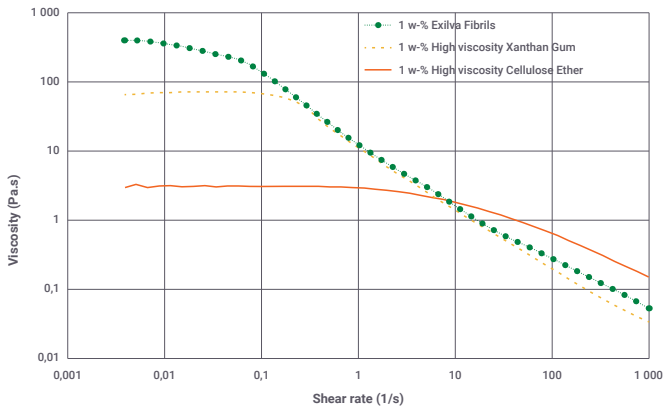
Complex viscosity describes the properties of the suspension at rest (without flow).

Increase in complex viscosity indicates better stabilization properties and higher resistance to settling and sedimentation in formulations.

Dynamic viscosity, often measured by Brookfield viscometer, describes the properties of the suspension at a given shear rate (with flow).

Increase in Brookfield viscosity indicates poorer flow properties such as lower pourability, harder pumpability and reduced workability.

Viscosity flow curve of Exilva as compared to xanthan gum and high viscosity cellulose ether

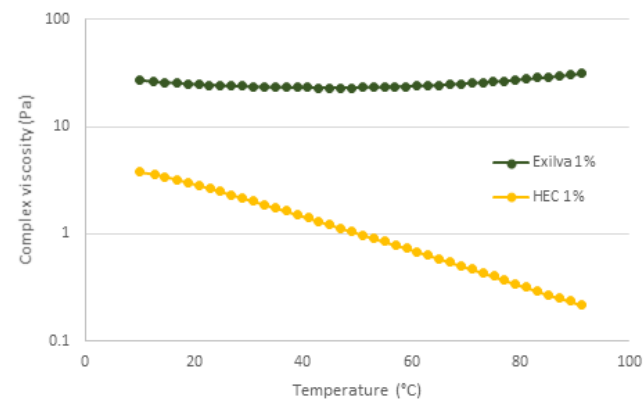


Shear thinning behavior of Exilva, xanthan gum and high viscosity cellulose ether.

The three materials are analyzed at the same active content (1 wt%) in order to eliminate any effect of concentration. Exilva has the highest viscosity at low shear with a very strong shear thinning behavior. Exilva has better stabilization properties and higher resistance to settling and sedimentation in formulations.

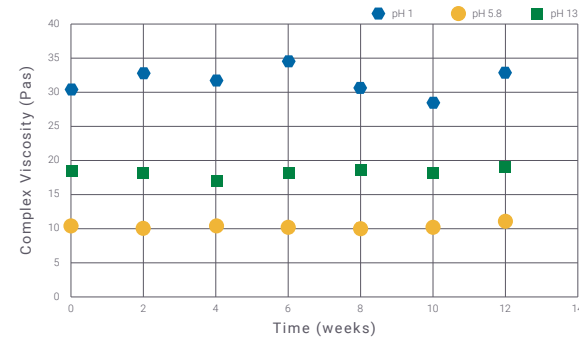
TEMPERATURE STABILITY

Complex viscosity of 1 wt% Exilva suspension measured over the temperature range 10–90°C and compared to that of 1 wt% hydroxyethyl cellulose. Exilva gives a stable viscosity and stability effect to water-based formulations at a wide temperature range (10–90°C). No gelation or loss of viscosity is observed with Exilva with change in temperature.



pH STABILITY

Complex viscosity at acidic, neutral and alkaline conditions.

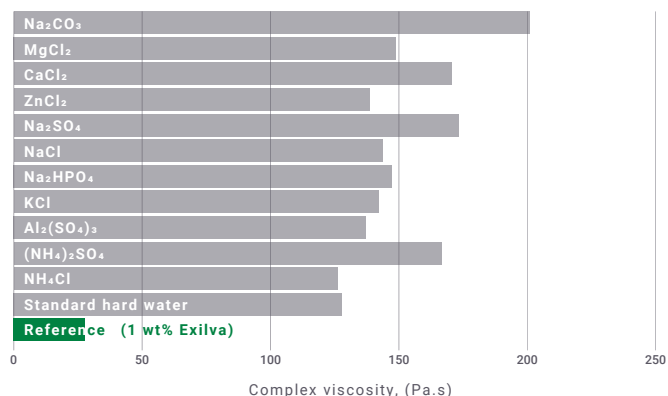


Complex viscosity of 1 wt% Exilva suspension in water at different pH.

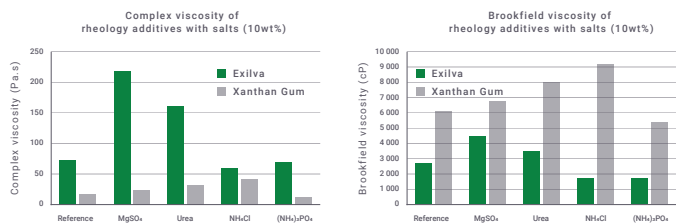
Exilva has a stable complex viscosity both in high and low pH formulations over at least 12 weeks. The high pH stability enables Exilva to be used as a structuring agent and stabilizer in highly acidic and alkaline formulations.

SALT TOLERANCE

Viscosity at rest and Brookfield viscosities with different salts.



Complex viscosity of 1 wt% Exilva in water (Reference) compared to 1 wt % Exilva suspensions with 10 wt% salt. Exilva tolerates salts very well, enabling its use as a rheology modifier in high salinity formulations. The complex viscosity of Exilva with high salt content increases as compared to Exilva in water indicating stronger stabilization properties with salts and confirming Exilva's excellent salt tolerance.



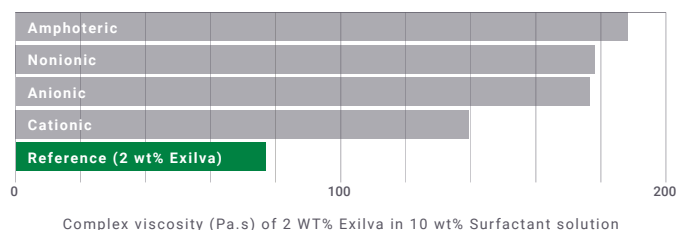
Complex viscosity and Brookfield viscosity of Exilva and Xanthan Gum with a selection of fertilizer salts as compared to the same viscosities in deionized water. The two materials are analyzed at the same active content (1 wt%) with salt concentrations of 10 wt%.

The results show that in these salts, Exilva has the highest viscosities at rest and the lowest Brookfield viscosities. This implies that Exilva has a better stabilization effect and prolonged shelf-life (higher resistance to settling) while maintaining good pourability. No gelation with Exilva at high salt content as compared to xanthan gum.

SURFACTANT COMPATIBILITY

Complex viscosity of 2 wt% Exilva suspension in water compared to 2 wt% Exilva suspension with 10% surfactants. Exilva has a good compatibility with the tested surfactants. The complex viscosity of Exilva with the surfactants increases as compared to Exilva in water indicating stronger stabilization properties with surfactants.

Note: Avoid foam formation when mixing Exilva with surfactants.



BULLETINS AVAILABLE:

STUDY ON COMPATIBILITY OF EXILVA WITH:

- Salts
- Solvents
- pH
- Surfactants

TECHNICAL BULLETINS:

- Better Dust Control of Coated Seeds with Exilva
- Exilva improves the rainfastness of agrochemical formulations
- Exilva as an uptake enhancer of actives;
 - Greenhouse tests and Field trials with Herbicides
 - Greenhouse test with Fungicide Propiconazole

...and more. Contact us to get your copy!



Borregaard

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