

Emulsions for Plant Protection

Formulation Guide for EC, EW and ME



Supporting our customers to formulate crop protection formulations is what we do. Every day. Akzo Nobel is a global company with a broad range of environmentally safe, biodegradable and cost effective solutions. This guide shows how Akzo Nobel products can be used to explore the full potential of your emulsions.



Key products for successful Emulsions

Berol® 9927, Berol® 9960, Berol® 9968, Berol® 9969

Nonionic / anionic emulsifier blends for standard aromatic solvent based EC formulations. The basic pair consists of Berol 9960 and Berol 9968. Depending on the HLB of the EC the emulsifier ratio needs to be determined by means of a ratio check. Berol 9927 and Berol 9969 can be used in more hydrophobic formulations.

Berol® 829, Berol® 904

Castor oil ethoxylates with respectively 20 (Berol 829) and 36 moles EO (Berol 904) are standard EC emulsifiers in combination with dodecylbenzenesulphonate salts.

Ethylan® NS-500LQ, Ethylan® 992, Ethylan® 954LQ

Ethylan NS-500LQ is a block copolymer. In combination with the alcohol alkoxylate Ethylan 954LQ and the anionic Witconate P1460EH suitable EC formulations based on dimethylamide solvents (Armids) will be achieved. The alcohol alkoxylate Ethylan 992 in combination with Witconate P1460EH is a superior combination for aromatic solvents such as Solvesso.

Lankropol® KPH70, Phospholan® PE169, Witconate™ P1460EH

To make an efficient emulsion, nonionic surfactants need to be combined with anionics. Lankropol, Phospholan and Witconate have carefully been selected from 3 different chemistries; sulfosuccinate (Lankropol KPH70), phosphate esters (Phospholan PE169) and dodecylbenzene sulphonate (Witconate P1460EH). Together with Berol's and Ethylan's they are necessary tools to formulate an EC, EW and ME. Lankropol and Phospholan are excellent for ME formulations.

All formulations in this guide have been tested in laboratory scale and comply with the following CIPAC methods; Emulsion characteristics CIPAC MT36, Emulsification stability CIPAC MT 39 & MT 46.1.3.

Emulsifiable Concentrates (EC)

While green solvents are gaining market share, emulsifiable concentrates (EC) have reinstated their position as popular agrochemical formulations. Their simple manufacturing process and relatively low cost remains important benefits. In addition, ECs generally have a better biological activity compared to dispersions.

Aromatic solvents continue to be popular solvents in several regions around the world because of their high solvency power and low cost. ECs based on these types of solvent require different emulsifier systems compared to the formulations based on green solvents.

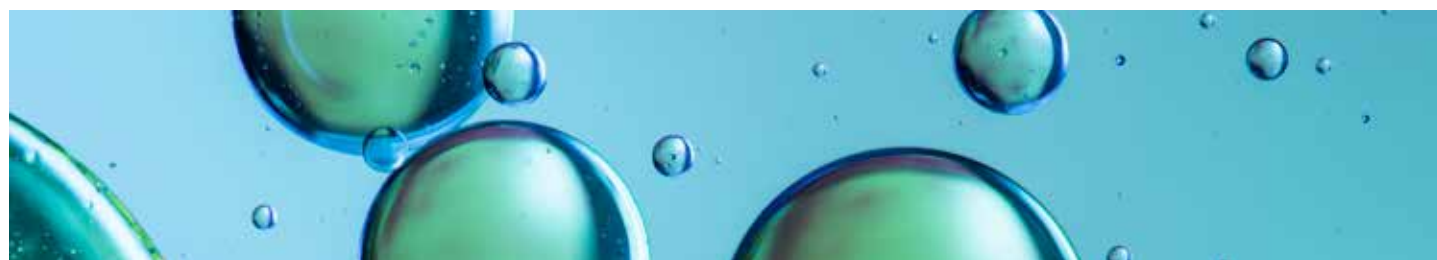
On dilution in water, ECs form a spontaneous emulsion with oil droplets ranging from 1 to 10 µm. Since the active ingredient reaches the target surface in a liquid form, EC's usually result in having a better biological performance compared to dispersions with the active in solid forms.

Preparation

The active ingredient is dissolved in the solvent and the emulsifier system is added while stirring. Typically 5 to 10% emulsifier is used.

Active Ingredient	Emulsifier	Solvent	Additional additive
Chlorpyrifos 200 g/l	20 g/l Berol 9960 30 g/l Berol 9968	Solvesso 150ND up to 1 liter	
Fluroxypyr-methyl 288 g/l	27 g/l Ethylan NS-500LQ 50 g/l Ethylan 954LQ 14 g/l Witconate P1460EH	200 g/l Armid FMPC Armid DM10 up to 1 liter	
Cyhalofop-butyl 200 g/l	10g Berol 9968	Solvesso 150 up to 1 liter	20 g/l Adsee AB 615 (adjuvant)
2,4-D ester 660 g/l (a.e.) (Iso octyl ester)	38 g/l Ethylan 992 58 g/l Witconate P1460EH		
Penthoate 500 g/l	30 g/l Berol 9969 20 g/l Agrilan AEC145	Xylene up to 1 liter	
Oxyfluorfen 240 g/l	80 g/l Berol 9927 18 g/l Ethylan NS-500LQ	220 g/l Armid FMPC 350 g/l Cyclohexanone Solvesso 150ND up to 1 liter	

Solvesso is a trade name by ExxonMobile Chemicals



Emulsions in water (EW)

The emulsion in water (EW) technology is generally used to formulate liquid or low melting point active ingredients. The major benefit of EW's is that water can be used as the continuous phase resulting in a lower tox profile and high flash point formulations.

Preparation

The emulsification can be spontaneous or low to high shear mixing may be required

- Mixture 1: Dissolve the active(s) in solvent(s) if needed. Add emulsifiers under gentle stirring.
- Mixture 2: blend water, antifoam and antifreeze.
- Add mixture 2 slowly and under moderate shear into mixture 1. Increase shear.
- A phase inversion will occur during this process (from W/O to O/W). Continue stirring and observe/measure droplet size until desired size is achieved (typically around 1µm).
- Add thickener to obtain desired viscosity (typically 500- 2000 mPa.s).
- Add biocide and fine tune the active content.

Active Ingredient	Emulsifier	Stabiliser	Solvent	Additional additive
Tebuconazole 250 g/l	80 g/l Berol 904 20 g/l Witconate P1460EH	5 g/l Agrilan 789	450 g/l Water 200 g/l Armid DM10	Thickener 1-3% Biocide 0.1-0.2% Antifoam 0.1-0.2%
Chlorpyrifos 450 g/l	20 g/l Ethylan 324 20 g/l Ethylan 992 20 g/l Agrilan AEC145 5 g/l Ethylan NS-500LQ		100 g/l Armid DM 0 100 g/l Solvesso 150 30 g/l MEG Water up to 1 liter	Biocide 1 g/l Antifoam 1 g/l

MEG = Mono Ethylene Glycol

Micro emulsions (ME)

Micro emulsions (ME) are thermodynamically stable liquid formulations with a relatively low concentration of active ingredient. They are suited to formulate actives for application at low dose rates. As such they usually find their way into the home and garden or wood preservation markets.

Micro emulsions contain the following components:

- Oil phase: can be liquid active ingredient or an active dissolved in a solvent
- Water phase: can also contain an active
- Emulsifiers

A co-surfactant may be required to reduce the interfacial tension between water and oil. Typical co-surfactants are alcohols, such as hexanol or butanol, but could also be a surfactant.

Micro emulsions can be a small-scale version of emulsions with a droplet size typically around 10 nm. This is about 100 times smaller than the typical emulsion droplet size. Micro emulsions can also be a more dynamic system with micro domains of oil and water. In contrast to an ordinary emulsion, where the droplets slowly coalesce and the phases eventually separate, the highly dynamic oil droplets/domains in a micro emulsions are stable and phase separation never occurs. Because of the small droplet sizes micro emulsions are transparent formulations

Preparation

Make a W/O emulsion by mixing active ingredient(s), emulsifiers and organic solvent (if necessary) and add approximately 4% water slowly under low shear mixing to a homogeneous mixture at about 40 to 50°C. By adding more water a phase inversion will occur from W/O to O/W.

Active ingredient(s) must be in liquid or semisolid (low melting point) state and insoluble and chemically stable in water. Solid active(s) can be dissolved in a minimum quantity of solvent.

Active Ingredient	Emulsifier	Solvent
Chlorpyrifos 190 g/l	200 g/l Lankropol KPH70 300 g/l Berol 829	100 g/l Solvesso 100 Water up to 1 liter
Cypermethrin 350 g/l	200 g/l Agrilan AEC145 170 g/l Phospholan PE169	90 g/l Armid FMPC 110 g/l EGDA Water up to 1 liter
Indoxacarb 50 g/l	120 g/l Agrilan AEC145 80 g/l Phospholan PE169	110 g/l EGDA Armid FMPC to 1 liter

EGDA = Ethylene Glycol Diacetate



Planet Possible: Our commitment to doing more with less

Our success as a company depends on sustainability. At AkzoNobel we have sharpened our focus on sustainability by reviewing our sustainability risks and opportunities against global trends and evaluating how they will impact our customers by 2020. We express the outcome as our Planet Possible approach to sustainability. It's our commitment to creating more value from fewer resources.



We know only too well that our future hinges on our ability to radically do more while using less.

- More innovation, less traditional solutions;
- More renewable energy and materials, less fossil-based;
- More value chain focus, less introverted thinking.

Employing our new strategy of radical efficiency, we work with customers and suppliers to open infinite possibilities to a finite world. Learn more at www.akzonobel.com/planetpossible

Number 1

is our position in the Materials industry group on the 2017 Dow Jones Sustainability Index.

At least 20%

is the share of revenue we aim to achieve by 2020 from products with a sustainability advantage for customers.

More than 25%

is the reduction we aim to achieve in our cradle-to-grave carbon foot print per ton of product by 2020.

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