2-Ethyl-Hexyl Alkoxylates as Adjuvants

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Change is a constant across multiple industries. The adjuvant world is no different. Regularly formulate and a new generation of crop protection practices steer pesticide and adjuvant formulators from traditional adjuvants such as tallow amine ethoxylates and alkyl phenol ethoxylates to adjuvants that offer better biodegradability, low aquatic toxicity, multifunctional performance and applicator convenience.

2-Ethyl-hexyl alcohols are nonionic surfactants that are commonly utilized in the household and industrial cleaning industry because of their excellent detergency, solubilization and emulsification performance. When formulated in pesticide and adjuvant formulations, this class of surfactants provides benefits such as wetting, rapid dissolution, rapid foam collapse, low odor and acceptability with actives such as glyphosate. These benefits coupled with low aquatic toxicity and ready biodegradability position 2-ethyl-hexyl alcohols for widespread adjuvant use.

Wetting
Coverage of pesticide spray solutions can be improved through chemical and mechanical methods. Surfactants are commonly utilized as chemical wetting agents, providing coverage on target by reducing the surface tension of an aqueous spray solution and improving adsorption on the solid surface.

Wetting properties of nonionic alcohol alkyl alcohols surfactants can vary widely depending on the choice of hydrophobe and the number and nature of alkylene oxide units. Highly branched hydrophobes tend to provide improved wetting and surface tension reduction. However, a high degree of branching has a negative impact on biodegradation. Moderately branched alcohol alkyl alcohols such as 2-ethyl-hexyl alkyl alcohols provide a good balance of properties, along with performance equaling or surpassing alkyl phenol ethoxylates while maintaining good biodegradability and low aquatic toxicity.

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combinations with improved performance are identified experimentally. Figures 1 and 2 summarize the spread index of 2-ethyl-hexyl alkylxate, two APGs, and their blends in ternary diagrams. When blended with a C8-C16 alkyl polyglycoside, 2-ethyl-hexyl alkylxates exhibit improved wetting performance exceeding values obtained with either surfactant alone. Values obtained with these blends exceed the spread index of nonylphenol ethoxylate (9EO) as well.

**Dissolution**

Agricultural tank mix adjuvant formulations are applied under a wide variety of conditions. Spring applications often utilize cold water for dilution with limited mixing capabilities. Therefore, it is important for the adjuvant formulation to rapidly dissolve upon dilution in the spray tank. The dissolution rate of a nonionic surfactant adjuvant formulation varies with surfactant composition. The dissolution rate of common nonionic surfactants in cold water was measured by adding the surfactant at a concentration of 10% by weight to 40 °F water with constant stirring. A timer was started upon addition and the time for the surfactant to fully dissolve in the cold water was recorded. Figure 3 illustrates the dissolution time of a variety of nonionic surfactates.

Nonylphenol ethoxylates and primary alcohol ethoxylates dissolve slowly (Figure 3) and form gels readily upon dilution with water. In this experiment, the dissolution time for these materials was well over 1 hour. 2-ethyl-hexyl alkylxate and blend of 2-ethyl-hexyl alkylxate with an alkyl polyglycoside provided a reduction in dissolution time of over 90% with dissolution times of less than 4 minutes versus over an hour. Rapid dissolution provides enhanced user convenience when applicators are operating in cold temperatures with limited agitation facilities.

**Bio-Efficacy**

Adjuvants are broadly defined as substances which improve the performance of an active ingredient. In order to evaluate the adjuvant performance of 2-ethyl-hexyl alkylxates, they were applied with glyphosate IPA to giant foxtail in the presence of 1% ammonium sulfate (AMS). For comparison purposes tallow amine ethoxylate with 20 EO (TAE20) was also included in the study. When used with glyphosate, 2-ethyl-hexyl alkylxates, improve the control of giant foxtail (Figure 4). The adjuvant effect improves as EO levels increase. The right balance of hydrophobe and hydrophile is crucial to achieve optimum results. The 2-ethyl-hexyl alkylxate with the highest level of EO evaluated provided similar efficacy to TAE20.

**Environmental Profile**

With the increase of urbanization, societal pressures, and regulation, environmental profiles of surfactants are becoming increasingly important. 2-Ethyl-hexyl alkylxates have an excellent environmental profile. These moderately branched surfactants are readily biodegradable (> 60% biodegradation within 28 days per OECD 301F) and exhibit low aquatic toxicity (LC50/EC50 between 10 and 100 mg/l in the most sensitive species tested). The combination of excellent biodegradability with low aquatic toxicity enabled these surfactants to be listed on CleanGredients where they can be achieved through these blends. 2-Ethyl-hexyl alkylxates also show good adjuvancy with glyphosate. The performance attributes and environmental profiles of 2-ethyl-hexyl alkylxlates position these materials as a viable option for future widespread adjuvant use.

**Conclusion**

2-Ethyl-hexyl alkylxates add a new environmentally friendly, nonionic alkylxate to formulators’ tool boxes. Their optimal molecular structure provides the desired biodegradability and low aquatic toxicity. 2-Ethyl-hexyl alkylxates provide comparable and often even better performance than nonyl phenol ethoxylates. They also complement eco-friendly alkyl polyglycosides that are commonly utilized in adjuvant formulations. Synergistic wetting and improved dissolution time can be achieved through these blends. 2-Ethyl-hexyl alkylxates also show good adjuvancy with glyphosate. The performance attributes and environmental profiles of 2-ethyl-hexyl alkylxlates provide a wide variety of applicability for future widespread adjuvant use.

**Figure 1** Spread Index of 2-Ethyl-Hexyl Alkylxate (EO), APGs, and Blends in a Ternary Diagram

**Figure 2** Spread Index of 2-Ethyl-Hexyl Alkylxate (EO), APGs, and Blends in a Ternary Diagram

**Figure 3** Dissolution Time

**Figure 4** Control of Giant Foxtail on Day 21

**Table 1** Design for the Environment Surfactant

- **Primary Alcohol**
  - EH6
  - EH8
  - EH10
  - EH12
  - EH14
  - EH16

- **Concentration**
  - C8-10 APG
  - C8-16 APG
  - TAE20

- **Granular Insecticide**
  - Herbicide
  - Fungicide

- **Agricultural tank mix adjuvant formulation**
  - Glyphosate
  - Glyphosate + 1% AMS
  - Glyphosate + 1% AMS + 0.25% TAE20

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