Propellants
by Chemours

HP DME/HP 152a Synergy Enhances Solubility in Aqueous Aerosol Formulations

Technical Information

As regulations continue to drive VOC levels down in aerosol products, water is becoming a larger part of modified formulations. With increased use of water, it becomes more difficult to achieve desired solubilities and single-phase propellant/solvent systems. One approach for increasing miscibility of high water systems has been to use HP DME (dimethyl ether). HP DME enhances solubility in aqueous systems, because of its ability to hydrogen bond with water. Hydrogen bonding is a weak-to-moderate attractive molecular force that exists between a hydrogen atom and the electrons of electronegative atoms, like oxygen and fluorine.

Of the propellants used in low VOC systems, HP DME exhibits the strongest hydrogen bonding properties; thus, its high solubility in water. Conversely, hydrocarbons have no hydrogen bonding properties and correspondingly low water solubility. Between HP DME and hydrocarbons, HP 152 exhibits weak hydrogen bonding properties; but, even these weaker forces help improve solubility in aqueous systems. Table 1 summarizes hydrogen bonding and solubility parameters for these propellants, showing the impact on water solubility. Note that while HP 152a water solubility is low, it is still up to 30 times higher than hydrocarbons.

Triangular diagrams are used to map solubility envelopes for multi-component propellant/solvent systems and can be used here to demonstrate the synergistic effect of HP 152a in aqueous systems.

Table 1. Hydrogen Bonding and Solubility Properties of Aerosol Propellants

Propellant	Solubility, wt%		
	Propellant in Water	Water in Propellant	Hydrogen Bonding Capacity
HP DME	35	6	Strong
HP 152a	0.28	0.17	Weak
Propane	0.0079	0.0168	None
n-Butane	0.0080	0.0075	None
iso-Butane	0.0080	0.0088	None
iso-Pentane	0.0084	0.0063	None

Figures 1 and 2 show solubility envelope for ethanol, water, and a propellant combination. In Figure 1, the propellant combination is a 50/50 mixture of HP DME/A-31; in Figure 2, the propellant combination is 45/55 mixture of HP DME/HP 152a. Comparing the two diagrams, note how the two-phase region is reduced ~30% when HP 152a is substituted for A-31, even with slightly less HP DME in the mixture.

Figures 3 and 4 show the same effect. The system again is an ethanol, water, and propellant combination. Figure 3 is a propellant mixture of 75/25 HP DME/A-46, and Figure 4 shows substitution of HP 152a. Again, the two-phase region is reduced ~45% with HP 152a, even with lower HP DME levels.

This synergistic effect of HP 152a with HP DME can be used advantageously to help improve miscibility of aqueous systems, while achieving lower VOC content required by regulations for aerosol products.

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Figure 1. Vapor Pressures and Solubility of HP DME/A-31 (50/50) with Ethanol and Water at 21.1 °C (70 °F)

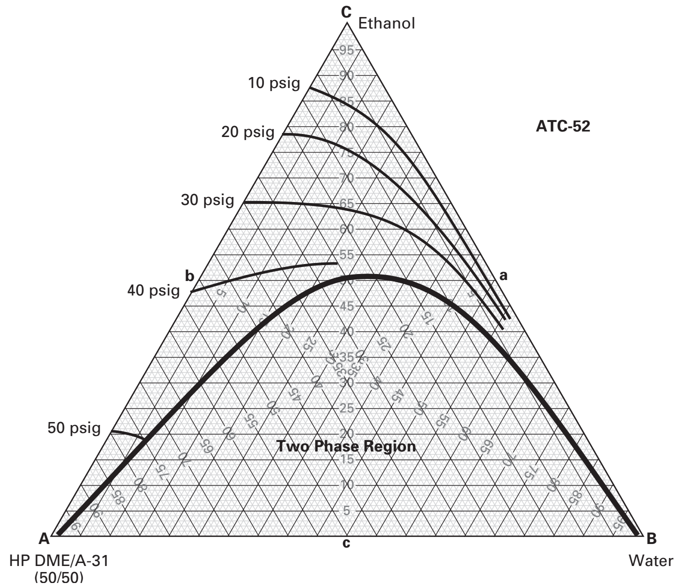


Figure 2. Vapor Pressures and Solubility of HP DME/152a (45/55) with Ethanol and Water at 21.1 °C (70 °F)

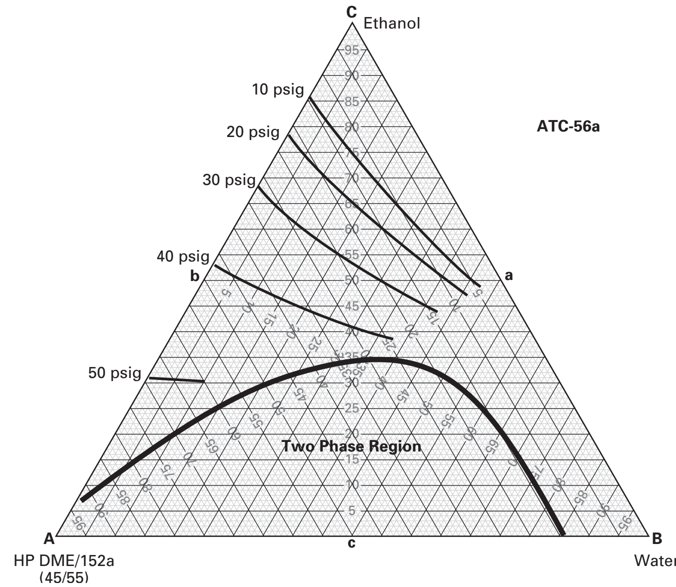


Figure 3. Vapor Pressures and Solubility of HP DME/A-46 (75/25) with Ethanol and Water at 21.1 °C (70 °F)

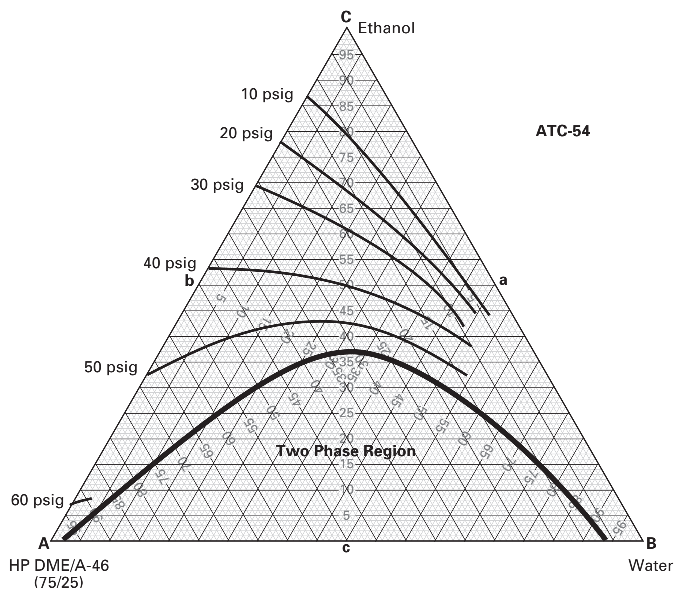
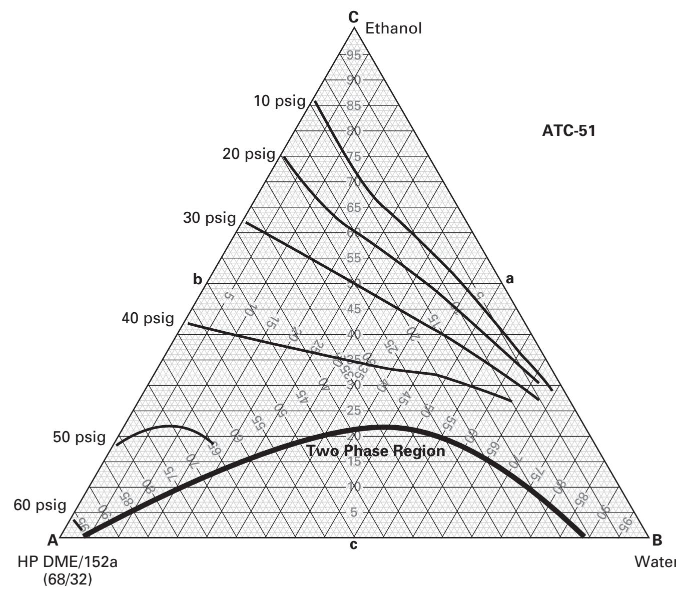


Figure 4. Vapor Pressures and Solubility of HP DME/152a (68/32) with Ethanol and Water at 21.1 °C (70 °F)



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