

## Thiosulfate

Thiosulfate ( $S_2O_3^{2-}$ ) fertilizers are clear liquids that provide a source of sulfur (S) and can be used in a variety of situations. They also contain other nutrients including nitrogen (N) as ammonium (ATS), potassium (KTS), calcium (CaTS), or magnesium (MgTS).

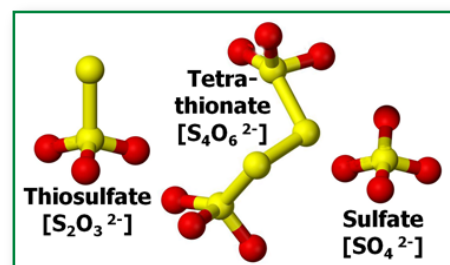
### Production

ATS is the most commonly used S-containing fluid fertilizer. It is made by reaction of sulfur dioxide, elemental S, and aqueous ammonia. Other common fluid thiosulfate fertilizers are similarly produced.

Thiosulfates are highly soluble in water and are compatible with many other fluid fertilizers. ATS is commonly mixed with urea ammonium nitrate (UAN) to produce a widely used fertilizer with the analysis 28-0-0-5 (5% S).

### Chemical Properties

Formula	Common name	Nutrient content	Density, kg/L	pH
$(NH_4)_2S_2O_3$	ATS	12% N; 26% S	1.34	7 to 8.5
$K_2S_2O_3$	KTS	25% $K_2O$ ; 17% S	1.46	7.5 to 8
$CaS_2O_3$	CaTS	6% Ca; 10% S	1.25	6.5 to 8
$MgS_2O_3$	MgTS	4% Mg; 10% S	1.23	6.5 to 7.5



### Agricultural Use

After application to soil, most of the thiosulfate quickly reacts to form tetrathionate, which is subsequently converted to sulfate. Thiosulfate is not generally available for plant uptake until it is converted to sulfate. In warm soils, this process is largely complete within one to two weeks.

Thiosulfate is a chemical "reducing agent" and it also produces acidity after oxidation of the S. Due to these properties, thiosulfate molecules have unique effects on soil chemistry and biology. For example, a band application of ATS has been shown to improve the solubility of some micronutrients. Local guidelines should be followed for maximum rates for placement in the seed row.

Thiosulfate can slow the rate of urea hydrolysis...the conversion of urea to ammonium ( $NH_4^+$ )...and reduce loss of ammonia ( $NH_3$ ) as a gas when ATS is mixed with UAN. This inhibiting effect is likely due to the formation and presence of the intermediate tetrathionate, rather than the thiosulfate itself. Nitrification...the conversion of  $NH_4^+$  to nitrate...is also slowed in the presence of ATS. Although the initial pH of thiosulfate fertilizers is near neutral, thiosulfate oxidizes to form sulfuric acid and the  $NH_4^+$  in ATS will form nitric acid, thus resulting in slight soil acidification in the application zone.

Thiosulfates may be applied through surface and overhead irrigation systems, sprinklers, and drip irrigation. Many of them are used in foliar sprays to provide a rapid source of plant nutrition (not recommended with ATS).

### Management Practices

Sulfur deficiencies are noted in crops throughout the world. Thiosulfates are valuable fertilizer materials because they are easy to handle and apply, require minimal safety precautions, and are compatible with many other common fertilizers. However, these fertilizers should not be mixed with highly acidic solutions since this will cause the decomposition of the thiosulfate molecule and subsequent release of harmful sulfur dioxide gas.

### Non-Agricultural Use

Thiosulfate materials are used in a variety of industrial applications. In photographic processing, they are used to bind silver atoms present in film or paper. Sodium thiosulfate is used in water treatment systems to remove chlorine. It is also used for gold extraction, since it forms a strong complex with this metal in a non-toxic process.

