

Formulation Calculations for Treatment Liquids A and B

US 8,945,631 B2 - LIQUID FOR TREATMENT OF CITRUS GREENING DISEASE AND TREATMENT METHOD USING SAME

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1. Treatment Liquid A

“Treatment Liquid A was prepared by diluting a Treatment Liquid A Stock Solution, which contains 14 g of citric acid per 100 mL of water and 40 parts by mass of Fe per 100 mL of water when taking the content of citric acid as 100 parts by mass, with desalted distilled water such that the concentration of total Fe ions is 15 mg/L.” **15 mg/L Fe equals 0.27 mM.**

- The concentration of Fe in the stock solution is 0.056 g/ml or 56 mg/ml or 56 g/L = 1000 mM.
- The concentration of citric acid in the stock solution is 140 g/L = 140 mg/ml = 0.73 M = 730 mM.
- 0.27 ml of the stock solution added to 1 liter yields 15 mg/L of Fe (0.27 mM) and 37.8 mg/L citric acid (0.197 mM).
- The molecule to molecule ratio (molar ratio) of Fe to citric acid is 1.37 Fe per citric acid OR 0.73 citric acid per Fe.
- Total mM of Fe + citric acid is 0.467 mM.

Treatment Liquid A Stock Solution

Treatment Liquid A Stock Solution contains 14 g citric acid and 28 g FeSO₄·7H₂O.

Citric acid 14 g/100 ml is defined as 100 parts by mass – i.e., 14 g = 100 parts, or 0.14 g/part. The concentration of citric acid is 140 g/L or 0.73 M or 730 mM.

Fe (40 parts by mass). Therefore, 40 parts Fe x 0.14 g/part equals 5.6 grams Fe per 100 ml. The concentration of Fe is 0.056 g/ml or 56 mg/ml or 56 g/L (1 M or 1000 mM).

FeSO₄·7H₂O (MW 278.01)

The proportion of Fe in FeSO₄·7H₂O is 0.20 (55.845/278.01). Therefore, 28 grams of FeSO₄·7H₂O are required to yield 5.6 grams of Fe. 5.6 g/100 ml Fe = 56 g/L = 1 M = 1000 mM.

Table 1. Treatment Liquid A Stock Solution

	g/100 mls	g/L	g/gal	oz./gal
FeSO ₄ .7H ₂ O	28	280	1,060	37
Citric acid	14	140	530	19

Table 2. Treatment Liquid A

	Liquid A Stock Solution			Liquid A Stock Solution	
	ml/L	ml/gal	ml/100 gal	oz./gal	oz./100 gal
Treatment Liquid A	0.27	1.0233	102.33	0.0346	3.46

2. Treatment Liquid B

“Treatment Liquid B was prepared by diluting a Treatment Liquid B stock Solution, which contains 14 g of citric acid per 100 mL of water and 13 parts by mass of 100 mL of water when taking the content of citric acid as 100 parts by mass, with desalted distilled water such that the concentration of total Fe ions is 15 mg/L.” **15 mg/L Fe equals 0.27 mM.**

- The concentration of Fe in the Liquid B Stock Solution is 0.0182 g/ml or 18.2 mg/ml or 18.2 g/L = 326 mM.
- The concentration of citric acid in the stock solution is 140 g/L = 0.73 M = 730 mM.
- 0.82 ml of the stock solution added to 1 liter to yields 15 mg/L of Fe (0.27 mM) and 114.8 mg/L citric acid (0.6 mM).
- The molecule to molecule ratio (molar ratio) of Fe to citric acid is 0.45 Fe per citric acid OR 2.22 citric acid per Fe.
- Total mM of Fe + citric acid is 0.87 mM.

Treatment Liquid B Stock Solution

Treatment Liquid B Stock Solution contains 14 g citric acid and 9.1 g FeSO₄·7H₂O.

Citric acid (14 g/100 ml). This is defined as 100 parts by mass - i.e., 14 g = 100 parts, or 0.14 g/part. The concentration of citric acid is 140 g/L or 0.73 M or 730 mM.

Fe (13 parts by mass). Therefore, 13 parts Fe x 0.14 g/part equals 1.82 grams Fe per 100 ml. The concentration of Fe is 0.0182 g/ml or 18.2 mg/ml or 18.2 g/L (0.326 M or 326 mM).

FeSO₄·7H₂O (278.01)

The proportion of Fe in FeSO₄·7H₂O is 0.20 (55.845/278.01). Therefore, 9.1 grams of FeSO₄·7H₂O are required to yield 1.82 grams of Fe.

Table 3. Treatment Liquid B Stock Solution

	g/100 mls	g/L	g/gal	oz./gal
FeSO ₄ ·7H ₂ O	9.1	91	345	12.17
Citric acid	14	140	530	19

Table 4. Treatment Liquid B

	Liquid B Stock Solution			Liquid B Stock Solution	
	ml/L	ml/gal	ml/100 gal	oz./gal	oz./100 gal
Treatment Liquid B	0.82	3.11	311	0.11	11

Conversions used

1 oz. = 28.35 grams

1 oz. = 29.57 ml

1 gal = 3.79 liters