TN14 — Interconversion of acidity units

Scope

Procedures are given to allow the interconversion of units of acidity commonly encountered in oenology.

Procedure

1. To convert volatile acidity (VA) in g/L as acetic acid to g/L as sulfuric acid:

1.000 g/L as acetic acid (MW = 60.05) $= \frac{1.000}{60.05}$ moles/L acetic acid

or $= \frac{1.000}{60.05}$ *equivalents/L*

ie. $= \frac{1000}{60.05}$ *milliequivalents/L (ie. meq/L)*

However, during titration of volatile acids by sodium hydroxide, the stoichiometry of the reaction is such that one mole of acetic acid is neutralised by one mole of sodium hydroxide. Each sulfuric acid molecule has two protons, however, while acetic acid only has one proton; hence the same addition of sodium hydroxide titrant will neutralise only half as many moles of sulfuric acid.

ie.: $\frac{1.000}{60.05}$ moles/L acetic acid $= \frac{1.000}{60.05} \times 0.5$ moles/L sulfuric acid

$= \frac{1.000}{60.05} \times 0.5 \times 98.08$ g/L sulfuric acid

Thus: 1.000 g/L as acetic acid $= \frac{1.000}{60.05} \times 0.5 \times 98.08$ g/L sulfuric acid

ie. **1.000 g/L of VA as acetic acid = 0.8167 g/L of VA as sulfuric acid**

ie. **Multiply VA as acetic acid by 0.8167 to give VA as sulfuric acid**

and **Multiply VA as acetic acid by 1000/60.05 to give VA in meq/L**

2. To convert titratable acidity (TA) in g/L as tartaric acid to g/L as sulfuric acid:

1.000 g/L as tartaric acid (MW = 150.09) $= \frac{1.000}{150.09}$ moles/L tartaric acid

However, during titration of titratable acids by sodium hydroxide, the stoichiometry of the reaction is such that two moles of sodium hydroxide are required to neutralise one mole of tartaric acid, as each tartaric acid molecule has two protons.

ie. $= \frac{2000}{150.09}$ *milliequivalents/L (ie. meq/L)*

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As each sulfuric acid molecule also has two protons, an addition of two moles of sodium hydroxide titrant will also be required to neutralise each mole of sulfuric acid.

ie. 1 mole of tartaric acid reacts with 1 mole of sulfuric acid

ie.: $\frac{1.000}{150.09}$ moles/L tartaric acid $= \frac{1.000}{150.09}$ moles/L sulfuric acid

$= \frac{1.000}{150.09}$ x 98.08 g/L sulfuric acid

Thus: 1.000 g/L as tartaric acid $= \frac{1.000}{150.09}$ x 98.08 g/L sulfuric acid

ie. **1.000 g/L of TA as tartaric acid = 0.6535 g/L of TA as sulfuric acid**

ie. **Multiply TA as tartaric acid by 0.6535 to give TA as sulfuric acid**

and **Multiply TA as tartaric acid by 2000/150.09 to give TA in meq/L**

3. General conversion factors for other acids

Using logic similar to that used above, a general expression can be derived for interconversion of acidity expressed on one form to that in any other form. For example, to convert from acidity expressed in terms of an acid H_nA to acidity expressed in terms of another acid H_mB:

1.000 g/L of acidity as H_nA

$$= 1.000 \times \frac{\text{molecular weight of } H_mB}{\text{molecular weight of } H_nA} \times \frac{n}{m}$$

where n and m are the number of protons present in each molecule of acids H_nA and H_mB, respectively.

For example, if we wish to convert acidity expressed as tartaric acid (molecular weight = 150.09, two protons per molecule) to acidity expressed as citric acid (molecular weight = 193.12, three protons per molecule):

1.000 g/L as tartaric acid

$$= 1.000 \times \frac{192.12}{150.09} \times \frac{2}{3}$$

$$= 1.000 \times 0.8534 \text{ g/L as citric acid}$$

Note—to convert acidity expressed as a given acid to acidity **expressed in meq/L**, the following conversion applies:

$$1.000 \text{ g/L of acidity as } H_nA = \frac{1.000 \times 1000 \times n}{\text{molecular weight of } H_nA} \text{ meq/L}$$

To assist with these conversions, the necessary data for some of the acids commonly found in wine are included in Appendix 1.

References

Amerine, M.A.; Ough, C.S. Methods for analysis of musts and wines. New York: Wiley-Interscience; 1980.

Windholz, M. ed. The Merck Index (10th edition). Rahway, N.J.: Merck & Co., Inc.; 1983.

Appendices

Appendix 1. Data required for interconversion of acidity units

To convert from acidity expressed as ⇒			**tartaric acid**	**malic acid**	**citric acid**	**lactic acid**	**acetic acid**	**sulfuric acid**
to acidity expressed as ⇒	**tartaric**	multiply by...	1	1.1193	1.1718	0.8331	1.2497	1.5302
	malic		0.8934	1	1.0469	0.7443	1.1165	1.3671
	citric		0.8534	0.9552	1	0.7109	1.0664	1.3059
	lactic		1.2003	1.3436	1.4066	1	1.5001	1.8369
	acetic		0.8002	0.8957	0.9377	0.6666	1	1.2245
	sulfuric		0.6535	0.7314	0.7658	0.5444	0.8166	1
No. of protons per molecule			2	2	3	1	1	2
Molecular weight			150.09	134.09	192.12	90.08	60.05	98.08

Appendix 2. Interconversion between EEC/French and Australian formats for titratable acidity

There are two differences in the approach taken by the EEC/French and the Australian industry. The European standard is to titrate to an end-point of pH 7.0, whereas we titrate to a phenolphthalein end point (approx pH 8.2). In addition, they express acidity as g/L sulfuric acid while we express as g/L tartaric acid. The latter difference can be corrected exactly according to the molecular weights of the acids, as described earlier; the difference in end-point cannot be corrected so accurately, but in our experience accounts for a difference of approximately 0.5 g/L of tartaric acid on average.

Therefore:

- To obtain an approximate conversion from the Australian expression of TA, one should subtract 0.5 g/L and then apply a conversion factor of 0.6535 to express in g/L H_2SO_4, as per the following example:

Australian figure TA = 6.5 g/L H_2T: (6.5-0.5) x 0.6535 = 3.9 g/L H_2SO_4

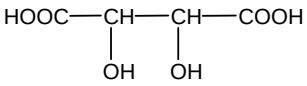
- Conversely, from EEC expression to Australian: divide by the conversion factor

$$\text{EEC figure TA} = 3.9 \text{ g/L } H_2SO_4 = \frac{(3.9)}{0.6535} + 0.5 = 6.4 \text{ g/L } H_2T$$

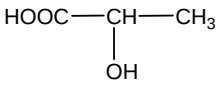
The Institute's automated system performs analysis of TA to both pH 7.0 and pH 8.2 on all samples, so that re-analysis or conversion of results is never required.

Appendix 3. Molecular formulae of organic acids commonly found in wine

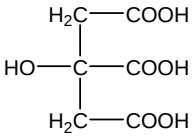
Tartaric acid



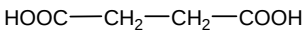
Lactic acid



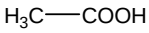
Citric acid



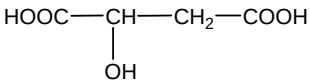
Succinic acid



Acetic acid



Malic acid



Sulfuric acid