Ionic Balance Calculations

It is well documented that within a water sample, the number of positively charged ions in solution (cations) should balance the number of negatively charged ion (anions).

It is possible to check whether this is true by performing an Ionic Balance calculation. This check should return a value of 0% if cations and anions are perfectly in balance, although it is accepted that values between ± 10% are satisfactory for this test.

When values are outside the ±10% range, there is often an assumption that some part of the analysis is wrong. However, often there are other explanations. These are discussed below.

1) LESS COMMON SPECIES

The Ionic Balance Calculation should encompass all anions and all cations with the sample. However, commercially this is not viable and a range of different calculations are available that cover the most commonly encountered cations and anions, such as the examples below.

Common Cations	Common Anions
Calcium Ca^{2+}	Chloride Cl^{-}
Magnesium Mg^{2+}	Sulphate SO42-
Sodium Na^{+}	Alkalinity HCO3-
Potassium K^{+}	Phosphate PO43-
Iron Fe^{2+}	Nitrate NO3-
Ammoniacal Nitrogen NH_4^{+}	
Manganese Mn^{2+}	
Aluminium Al^{3+}	

When performing an Ionic Balance calculation, if it is suspected that a less common cation or anion is present within the sample, then this needs to be included within the calculation. If this is not done, then the calculation will fail to give the correct result. The Company producing the sample should generally know what chemicals are used on their site and therefore what their waste might contain.

The number of less common chemicals is extensive, with examples including borate, borax, molybdate, bromate, bromide, iodate, iodide, cyanide, lithium, barium and silicate. If any of these are present within the sample at significant concentrations, they must also be included within the calculation for it to work.

2) SOLUBLE AND TOTAL ANALYSIS

A second cause of erroneous results from Ionic Balance Calculations is connected to confusion regarding "Total" and "Soluble" analysis. The two types of analysis cannot be entered into the same calculation.

Ionic Balance Calculations only work when balancing anions and cations that are naturally in solution. If some analytes are measured in their natural soluble state, while others are increased through additional extraction, then the results will not match. In reality, this means that Ionic Balance Calculation will only work when the entire assessment has been performed on the filtered (soluble) portion of the sample only.

3) ORGANIC SALTS

The ionic balance calculations are derived from potable waters and assume that only inorganic species contribute to the sum of anions and cations. If significant concentrations of organic salts are present, these will often cause an Ionic Balance Calculation to fail. Again, the supplier of the sample should be aware of whether organics salts are likely to be present within the sample

4) OTHER CHECKS

When an Ionic Balance Calculation does not give results between ± 10%, other checks are possible to identify what might be responsible for the disparity.

Ionic Balance calculations should only be performed on the filtered sample. If a Dissolved Solids assessment is also performed on the filtered sample, then the sum of all cations and anions should be equivalent to the dissolved solids evaluation. If this is not the case, then the presence of organic salts or less common species becomes more likely.

Other tests that can be helpful when looking at Ionic Balance Calculations are sample conductivity, TOC and suspended solids.

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