

Traceable pH and ISE measurements in clinical chemistry (Mesurages traçable de pH et ISE dans la chimie clinique)

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Abstract. Reliable analysis results are indispensable in clinical chemistry for unambiguous diagnosis. Hence today traceability of the patient measurement to the SI system is established within the scope of a traceability system consisting of a national metrology institute and routine- and reference laboratories.

1 State of the Art of pH- and ISE measurements in clinical chemistry

1.1 pH measurements

Traceability of pH measurement results in general is secured by calibration of a pH measuring device using calibration solutions, which are linked to internationally agreed standards. In clinical chemistry samples usually contain proteins or even blood cells, which can have a disturbing effect at the liquid junction of the used pH electrode. These effects have to be taken into account with the calculation of the measurement uncertainty.

1.2 ISE measurements

Currently in clinical chemistry analytical chemical results for metal ions are reported in terms of substance concentration relative to the substance concentration in primary aqueous calibrators (i.e. mol per litre) as recommended in the IFCC guidelines.[1] However, ion selective electrodes (ISE), which are widely used in clinical chemistry, measure ion activities. The measured activities are transformed into concentrations using empirical factors, which are only valid for “normal” physiological conditions, resulting in false positive or false negative results of the metal ion concentrations in case of special conditions like cancer or renal trauma.

For historical reasons and in order to avoid confusion with the introduction of ion activities, concentration values are still reported in clinical chemistry to date.

The aim of a collaboration project between PTB and representatives from the clinical chemistry section is to bring ISE measurement results for sodium and potassium of blood serum in consent with results from ICP-OES

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measurements aiming to establish a reliable link between activities and concentrations of metal ions in blood serum.

2 Development of a traceable pH- and ISE reference setup for clinical chemical purposes

At PTB (Physikalisch-Technische Bundesanstalt) a flow-through measurement setup was developed, which allows SI-traceable measurements of pH and metal ion activities at the same time in small volumes.

The use of a miniaturised flow through cell allows pH- and ISE measurements, which are traced back to the SI system of units by use of primary calibration standards. The use of a special commercial gel-filled pH glass electrode which is suitable for pH measurements in protein containing solutions like blood serum together with a precise temperature control ($< \pm 50$ mK) results in measurement uncertainties of less than 0.02 pH units.

Traceability of the ISE measurement results was established by uncertainty approximation of ion activity coefficients by Pitzer theory.[2] These coefficients are used to calculate ion activities from molalities of the gravimetrically prepared aqueous calibration standards. The novel ISE measuring procedure was validated in an international laboratory comparison.[3]

The combined pH/ISE measurement setup will be transferred into practical use together with collaboration partners from the clinical chemistry section.

3 References

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