All-Solid-State Contact Fe (II) Selective Electrode

At a Glance

Researchers at Colorado State University have developed an all solid-state contact Fe (II) selective electrode to directly quantify Fe (II) ions in aqueous medium. The novel electrode consists of a polymer, plasticizer, ionophore, and lipophilic additive for the construction of the polymeric membrane. All solid-state contact ion selective electrodes, such as this, can provide a new platform by replacement of inner reference solution of analyte ion with a solid contact layer. These electrodes show better selectivity, sensitivity, pH range, response time, and overall require less maintenance as compared to traditional ion selective electrodes. In addition. they are cost effective, stable, and can be miniaturized and adapted to small portable devices.

Fe (II) Selective Electrode Performance:

- Calibration sensitivity: 29.99 +/- 0.25 mV/decade
- Wide concentration range: 1.0×10^{-1} to 1.0×10^{-5} M
- Detection limit: 4×10^{-6} M
- pH range: 3.0-5.5

Background

Iron is the most crucial element for all metabolic processes including transportation and storage of oxygen, electron transport in enzymatic reactions, and production of enzymes. However, deficiency and excessive accumulation of iron in the human body cause various health problems including Huntington's, Parkinson's, Alzheimer's diseases and liver, heart, and pancreas failure. Acid mine drainage (AMD) from coal and mineral mining operations is a difficult and costly problem that has resulted in more than 7,000 kilometers of polluted streams in the eastern U.S. alone. Iron, specifically, has the highest concentration among all metals in AMD (up to 200 mg/L) causing extreme hazard to both aquatic life and human health.

Microbial redox cycling of Fe also plays an important role in controlling the mineralization and preservation of soil organic matter and the fate of contaminants and nutrients. Increased concentrations of Fe have been observed in both European and North American freshwaters over the last few decades.

The current methods used to quantify Fe (II) ions in environmental, industrial, and medical water samples are inductively coupled plasma mass spectrometry (ICP-MS) or colorimetry. With the use of ICP-MS method, a value for detection of Fe (II) is achieved by subtraction of the Fe (III) value from total Fe value that is obtained from a separate sample analysis. Thus,

Opportunity

Collaboration and Funding Interest Welcome

Inventors

Tugba Ozer
Thomas Borch

Reference Number

2020-095

this technique is not capable of direct determination of the Fe (II) concentration. Alternatively, it is possible to detect Fe (II) in aqueous solutions using colorimetric methods that rely on complexation of Fe (II) ions by a chromophore. In addition, some methods based on synthetic organic probes using fluorescent signal have been reported for quantitative detection of Fe (II). However, the analytical performance can be adversely affected by autofluorescence of the matrix and photobleaching. Furthermore, these methods are time consuming, require expensive stationary instrumentation, sample pretreatment, and specialists to operate, and do not allow in-situ analysis.

Benefits

- Good potentiometric performance
- High sensitivity and selectivity
- Rapid and reversible response (<30 s)
- Portable – allows for in-situ and on-time analysis of Fe (II)
- Require less maintenance that traditional ion selective electrodes
- Cost effective and stable

Applications

- Monitor iron content in aqueous medium (e.g. wastewater, drinking water, acid mine drainages, water supply for commercial beverage production, iron contamination in oil fields, etc.)
- Both private and govt. organization that require measurement of iron content (e.g. schools, hospitals, other industries – all provide safe drinking water to public)
- Both Environmental and Industrial applications
- Potential to be modified to other ion selectivity