ICRN 20

IAPWS Certified Research Need - ICRN

Sensors for Use at Elevated Temperature in the Plant Cycle of the Power Industry

The IAPWS Working Group Power Cycle Chemistry has examined the published work in the area of high temperature sensors for the power cycle and recognizes that there is a requirement for work to be pursued in this field and has prepared this document to assist potential investigators in obtaining sponsorship.

There is a need for the power industry to adopt the use of such sensors for monitoring corrosion and other issues in cycle chemistry. However the availability of commercial products is limited. In addition, existing information for measurements made by sensors at room temperature can not be adequately related to high temperature use.

This ICRN specifies the main questions that must be answered for the development of high temperature sensors.

Although encouraging this work, IAPWS is not able under its statutes to provide financial support. The IAPWS contact can provide any further development information and will act as a liaison between research groups.

Issued by the
International Association for the Properties of Water and Steam

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Background

Over the past two decades, attempts have been made to measure chemical variables at temperature (and pressure). Some sensors have been produced and several publications have been made on the theoretical calculation of values at temperature.

Although sensors have been designed for operation at elevated temperatures e.g. parameters of temperature, pressure and flow, instruments for analytical measurements under similar conditions are rarely encountered. There are several reasons for this situation:

-materials of construction
-actual construction of the sensors
-inappropriate for measurements in low-density water substance
-handling
-temperature compensation (temperature correction)

Owing to the maintenance required for sampling and conditioning systems, it has been the desire of the plant chemistry personnel to install sensors directly into the process streams found in the plant cycle of power plants.

In several instances, chemists have been tempted to abandon the on-line analysis systems owing to complexity and the need for intensive maintenance. This drastic measure can negate any warranty issues in the event of failure of materials and where no proof of adherence to manufacturer specifications can be provided.

In addition, according to EN12952-12:2003, it is now mandatory in Europe to measure (reported at 25°C) at least acid (cation) conductivity, pH and dissolved oxygen in the plant cycle. Most countries in Europe have adopted this standard. The requirements contained in this document are in accordance with other international guidelines and manufacturer specifications.

Research Questions to be Answered (in order of priority)

1. Are suitable materials of construction available to manufacture high-temperature sensors for pH (and ORP), conductivity, dissolved oxygen and corrosion rate?
2. How will these sensors be operated safely within the power plant environment?
3. How can these sensors be calibrated at the temperature of measurement

Other questions, on the interpretation of the data from such sensors (will be specified in a following ICRN):

- How will it be possible to relate acid conductivity measurements to in situ specific conductivity measurements?
- Is sufficient data available to characterize the measured values from 0°C to the critical point of water?
- How may the measured values be corrected to ambient conditions so that the results at elevated temperature are meaningful to the plant chemist and operator?
- Can corrosion rates be directly measured in high-temperature water?

Outputs

- Development of a repository of current knowledge (existing guidelines, instruction sheets, standards, research, plant experience, scientific papers)
- Investigation into results obtained using existing sensors – successes and failures
- Identification of shortcomings of existing materials of construction of high temperature sensors
- Development of a device to test sensors under simulated plant cycle conditions
- Development of new designs
- Determination of reliability of sensor materials for use under elevated temperature and pressure conditions
- Development of in situ calibration techniques
- Collection of data for each variable over the temperature range 0°C to the critical point of water
- Development of suitable temperature correction algorithms

Beneficiaries

1. Plant manufacturers
2. Utilities and supporting organizations
3. Manufacturers of sensors for the power industry

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