framatome

COMBO

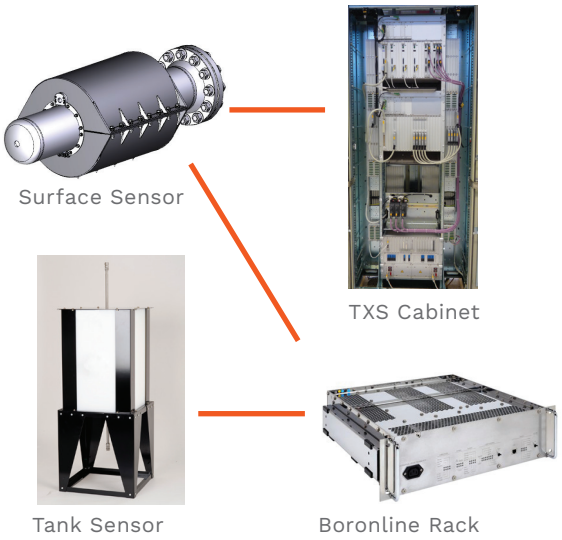
Continuous Measurement of Boron Concentration System

Early detection of disturbances in the concentration of boric acid used to prevent criticality events and improve operations

Challenge

In several nuclear processes, control of boron concentration is either mandatory or necessary to achieve operational or safety margins. Particularly, in most of the pressurized water reactor (PWR) types, slow changes in reactivity are controlled using boric acid dissolved in the coolant of the primary circuits. This makes it necessary to quickly access the boric acid concentration in safety or non-safety systems under different conditions, i.e., different diameter pipes, bypassed or even inside a tank.

Today it is still standard practice to measure boric acid concentration on a non-continuous basis via chemical analysis from sampling systems for those usages (titration). This non-optimal practice is often considered as costly and slow.



Solution

The Framatome Continuous Measurement of Boron Concentration (COMBO) system allows the early detection of disturbances on a nearly real-time basis.

The measuring principle is based on the absorption of neutrons by the isotope B-10, which depends on the boron content of the coolant. Neutrons from an Am/Be source diffuse through the coolant and some of these neutrons are absorbed. The remaining neutron radiation is then detected by appropriately positioned counter tubes.

In order to fit with your installation, Framatome offers two types of sensors: a surface sensor which can be directly and non-intrusively mounted on any pipe (with any diameter DN80-DN500), and a tank sensor deported from the main circuit through a bypass sampling system.

For signal acquisition and processing, the Framatome I&C TELEPERM XS platform is used for Safety Class 1 applications, and the Framatome I&C Boronline rack is used for Safety Class 2, 3 or non-safety applications.

Customer benefits

- Early and rapid detection of disturbances in the boric acid concentration within the primary circuit, fuel pool cooling system, sampling system or any other system
- Accurate measurement within seconds
- A fully qualified system for safety or non-safety applications
- No welding intervention is required on pipes of any diameter, and simpler integration into an expert system to supporting plant chemistry makes installation easier.
- No scheduled preventive maintenance on the sensor is needed, reducing costs
- The COMBO solution makes titration obsolete and improves efficiency of operations

Features

Quick response time
- Measurement within first 10s (depending on filter type)
- Highest accuracy (up to 1 to 2%): <1 min

Sensor unit installation
- Non-intrusive installation mounted directly on any pipe diameter DN80 – DN500 without any need for welding
- Or installation of a sensor tank with bypass

Medium temperature
- Measurement up to 200°C

Electronics
- Stand alone
- Or integrated in existing cabinets

Qualification
- The COMBO system is qualified for all safety-related applications. Type tests and seismic load test have been performed, TELEPERM XS and Boronline hardware and software are qualified according to international nuclear standards.

Maintenance
- Easy service and maintenance by means of automatic diagnostics of all components

Technical information

Measurement range:
- 0–1600 ppm boron-10
- 0 – 8000 ppm boron total (20% enriched) (can be adapted for specific projects requirements)

Reference accuracy*
- 20 ppm for boron concentration < 1000 ppm
- 2% for boron concentration ≥ 1000 ppm
- Response time < 1 min (depending on filter type)

Radiation within working area
- < 100 µSv/h (on equipment surface)
- < 10 µSv/h (in 1 m distance)

Sensor unit
- Neutron source: Am-Be – 3.7 x 10^{10} Bq
- Neutron detectors: boron-lined counter tubes
- Coaxial cable: super-screened
- Temperature sensor: PT100

Medium temperature
- Measurement between 0 to 200°C medium temperature
- Withstands temperature of primary circuit
- Environmental Temperature
- 0 °C to +60 °C

Qualification
- Based on IEC60780 and IEEE323

Key Figures

3 safety classes
200°C median temperature
up to **DN500** pipe diameter
2 types of sensors

References

Belgium (7 pcs.)
China (15 pcs., incl. 6 on TSN)
Finland (7 pcs., incl. 3 on OL3)
France (63 pcs., incl. 7 pcs on FA3)
Slovakia (18 pcs.)
Slovenia (1 pc.)
UK (4 pcs.)
USA (1 pc.)

*The stated reference value (total uncertainty) comprises statistical and systematic uncertainties and is the average uncertainty at a statistical deviation of 1 sigma. The actual accuracy of the measured boron concentration depends on several factors, e.g. accuracy and frequency of calibration and parameterization of signal processing filters. The accuracy of the reference measurement used for calibration of COMBO is not included in this value.

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is **our** everyday **commitment**