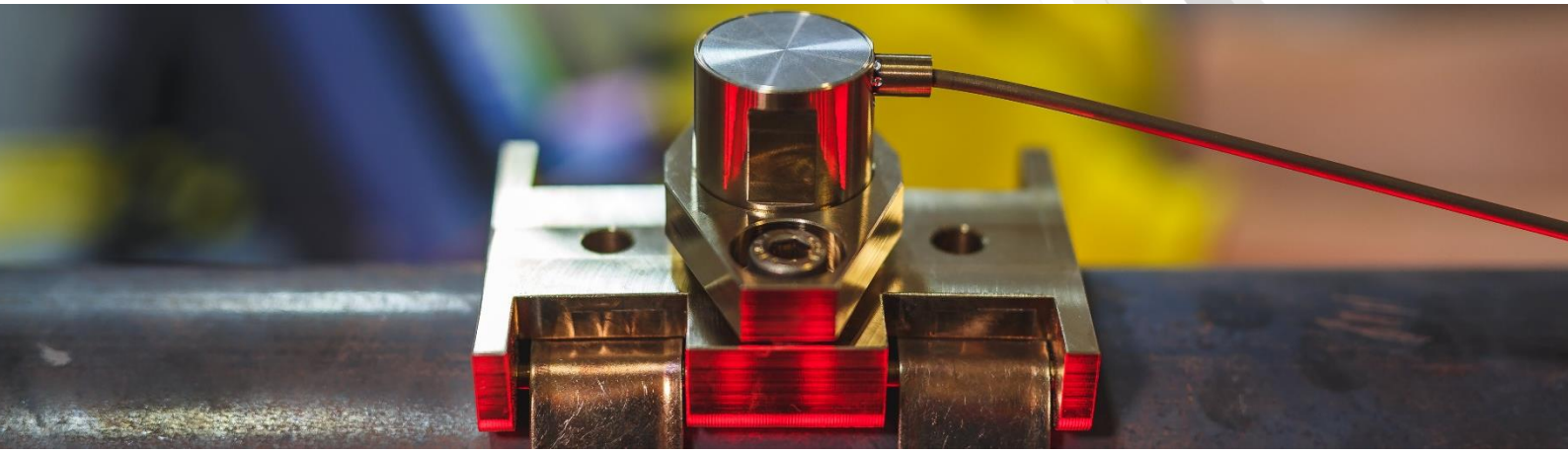
hotsensell® | Powered by ionix

ionix ADVANCED TECHNOLOGIES

In-service gas void detection and monitoring in nuclear energy核能领域在线气体空洞检测与监测

Online, high-temperature gas void detection to reduce personnel dose, reduce costs and increase safety.
在线高温气体空洞检测以减少人员配量，降低成本并增加安全性。



Overview概述

The ability to detect gas voids in cooling water lines was required by one of the largest electric power holding companies in the US, generating up to 51,000 MW of electricity from mixed sources, including 6 nuclear plants. Overhead cooling lines which are routinely flooded must be inspected to ensure they do not have any trapped air in the form of voids. These measurements are currently performed manually using an inspector. This requires access to high areas via rope or scaffolding and potential radiation dose exposure. The customer required a fixed transducer which could be accessed from ground level to:

美国最大的电力控股公司之一，该公司从混合来源可生产高达5.1万兆瓦的电力，其中包括6座核电站，其要求具备检测冷却水管线中的气体空洞。经常进水的架空冷却管线必须进行检查，以确保它们没有任何以空隙形式滞留的空气。这些测量目前是使用检查器手动执行的。这需要通过绳索或脚手架进入高空，并暴露在潜在的辐射剂量下。客户需要一个固定的传感器，可以从地面到：

1. Minimise exposure to staff by reducing the time spent in the environment
   通过减少在环境中的时间，减少员工的暴漏时间
2. Reduce the cost of inspection by removing the need for repeated rope access and scaffolding
   无需重复使用绳索和脚手架，从而减少检查成本
3. Increase overall plant safety by reducing the exposure of staff to working at height.
   通过减少工作人员在高空工作的暴露，提高工厂的整体安全
4. Simplify data collection and improve measurement reliability compared to manual inspection.
   与人工检测相比，简化数据采集，并提高测量可靠性

The Challenge 挑战

The water-cooling lines see temperatures vary from room temperature up to 280°C. A solution was required which:
水冷线的温度范围从室温到280 ° C不等。需要解决以下问题：

a) Could survive continuous operating temperatures up to 280°C and survive repeated thermal cycling.
   能承受280 ° C的连续工作温度，并能承受反复的热循环。
b) The materials of construction must comply with national regulations and must be able to survive extended exposure to radiation.
   建造材料必须符合国家规范，必须能够经受长时间的辐射。
c) Must have a robust and reliable deployment system which can be retrofitted to existing pipes without modification.
   必须有一个稳健可靠的部署系统，可以在不做改动的情况下对现有管道进行改造。

+44 (0) 1484 505 859
contact@ionix.at
ionixadvancedtechnologies.co.uk

hotsense® | Powered by ionix

The Solution解决方案

The HotSense™ high-temperature ultrasonic transducer offers the ability to operate continuously within nuclear plant environments to provide permanent fixed-point monitoring of asset integrity and gas void measurements. Deployed directly on to the pipe asset using associated clamp-on deployment allows the sensors to be installed without isolation or shutdown of plant, and under insulation across -55 to +380 °C. The ultrasonic platform has also been proven to be able to be radiation resilient, showing no degradation with exposure to 11 MGy gamma(at 367 Gy/min), and 2.6 x 10^{18} neutrons.cm^{-2}

HotSense™ 高温超声波传感器能够在核电站环境中连续工作，提供资产完整性和气体空洞测量的永久定点监测。通过相关卡箍安装，传感器可直接安装在管道资产上，无需隔离或停车，且温度-55 到+380 ° C之间时，安装在保温层下。超声平台也被证明具有辐射弹性，在暴露于11 MGy γ (367 Gy/min)和2.6 x 10^{18} neutrons.cm-2时没有出现降级。

Mounted on the top of pipes, ultrasonic flaw detectors are used with the HotSense™ transducers to detect the pipe far surface reflection that is present only when the pipe is completely filled with water. This signal is undetecable when a void is present. If this occurs an inspector is dispatched to size the extent of the void.

传感器安装在管道顶部，超声波探伤仪与Hotsense™传感器一起使用，以检测只有在管道完全充满水时才会出现的管道远表面反射。当存在空洞时，这种信号是无法检测到的。如果发生这种情况，将派出一名检查员对空洞的范围进行评估。

Execution实施

HotSense™ transducers were installed across a single site. Cable extensions were used to allow measurements to be made from ground level, preventing the need for repeated rope access or scaffolding. Measurements were made from the transducers after installation and after two thermal cycles from 21 °C (70 °F) to 204 °C (400 °F) . Measurements were made using a GE USM Go+ and performed according to the customer's standard procedure. Calibration of the transducers prior to installation and before each measurement was achieved by calibration against a steel reference sample. The presence of a gas void was detected by the loss of the pipe far-wall reflection. The correct location of this reflection was determined by assuming a speed of sound of water roughly 4 times slower than steel.

Hotsense™传感器安装在单个站点上。使用了延伸的电缆，以便从地面进行测量，避免了重复使用绳索或脚手架的需要。传感器安装后，经过21°C(70°F)到204°C(400°F)的两次温度循环后进行测量。使用GE USM Go+，按照客户的标准程序进行测量。传感器在安装前和每次测量前的校准都是通过对钢参考试块的校准来实现的。通过管道远壁反射的丢失可以检测到气体空洞的存在。其反射的正确位置是通过假定水的声速大约比钢的声速慢4倍来确定的。

Highlights亮点

- The HotSense™ sensors were quick and easy to install using the supplied coupling and clamping systems.
  使用所提供的耦合和卡箍系统Hotsense™传感器安装非常迅速、容易。
- The HotSense™ sensors performed well both immediately after installation and following 3 months in operation.
  Hotsense™传感器在安装后立即使用和运行3个月后都表现良好。
- The sensors operated to NDT transducer standards and were compliant with current measurement procedures.
  该传感器符合NDT传感器的标准，并符合当前的测量程序。
- Transducer cable extensions allowed data to be safely collected from ground level minimising the exposure of staff to working at height and reducing their radiation exposure time.
  传感器电缆的延伸可以安全地从地面收集数据，最大限度地减少工作人员在高空工作的暴露，并减少他们暴露在辐射下的时间。
- Plant and operator safety was improved due to the application of the HotSense™ technology.
  由于应用了Hotsense™技术，电厂和操作人员的安全得到了提高。