APPLICATION NOTE

ANALYSIS OF WASTE-GAS / OFF-GAS OXYGEN AND HYDROGEN IN NUCLEAR POWER PLANTS

(HACH ORBISPHERE 512 WITH CHANNEL COMPENSATION)

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Analysis of Waste-Gas / Off-Gas Oxygen and Hydrogen in Nuclear Power Plants

(Hach Orbisphere 512 with Channel Compensation)

Benefits:

- Analyzer detects potentially explosive conditions
- One compact system for both O_2 and H_2 online measurements
- Reliable gas analysis reduces possibility of unscheduled outages
- Unrivaled accuracy and response time for fast detection of process change
- Rugged construction to handle the high requirements of the nuclear industry

Application Description:

All nuclear power stations must be equipped with waste-gas / off-gas systems to handle gaseous wastes in compliance with regulatory requirements. The gaseous waste originates primarily from different gases dissolved in the coolant, radiolytic decomposition of water into hydrogen (H_2) and oxygen (O_2), and gases added to the process, such as hydrogen and nitrogen (N_2).

Designs of waste-gas / off-gas systems often differ considerably from plant-to-plant; however, there are some features that remain common to all systems. In Pressurized Water Reactor (PWR) systems, gas volumes are rather small because the primary system is sealed. Gases in PWR systems are typically compressed and stored in decay tanks for 30–45 days before being released into the environment in a controlled manner. In the case of Boiling Water Reactor (BWR) systems, the volume of released gas is much larger because the feed water is continuously deaerated and the gas produced at the deaerator must be treated as radioactive, due to the fact that it has come in direct contact with fuel. BWR gases are held for a short time (often around 30 minutes), then diluted with air and released into the atmosphere.

Some systems are using recombiners to bond oxygen with hydrogen waste-gas by sending the gas through a catalytic reactor. The result of the bonds formed is water, which significantly reduces the amount of gaseous waste needing further treatment. A controlled amount of O_2 may be added to react with the H_2 to achieve the stoichiometric H_2/O_2 ratio. Another important benefit is reduction of risk as hydrogen concentrations drops below the explosive mixture limit of 4%.

It is critically important to keep tight process controls in place in this environment. For essential analysis parameters, the Hach Orbisphere in-line waste-gas / off-gas analyzer offers distinct advantages over conventional methods and processes.

First, since waste-gas / off-gas instrumentation is used to detect and correct conditions that may propagate an H_2/O_2 explosion, reliability is crucial. With conventional H_2/O_2 analysis equipment, slight changes in temperature, pressure, and flow, as well as the presence of moisture in the process stream, can significantly affect the output signals. Additionally, start-up time, routine maintenance, and multiple point calibrations all demand many hours that operators often cannot dedicate during critical operating periods. Conventional equipment can become fouled by water and unreliable over time, making regulatory compliance an issue; additionally, jeopardizing “tech spec” measurements can result in an unscheduled outages and costly downtime.

Lastly, conventional H_2/O_2 analysis systems require complex supporting equipment that are exposed to the risk of external system leakage and personnel contamination. Not only does this present an As Low As Reasonably Achievable (ALARA) problem, but it could also become a regulatory concern with the possibility of an uncontrolled release of waste-gas.

Installation recommendations:
The Hach Orbisphere Waste-Gas / Off-Gas Analyzer provides extremely reliable and accurate in-line measurement of O_2 and H_2 levels in waste-gas / off-gas streams without the challenges associated with conventional analysis systems. The Hach Orbisphere analyzer offers a rugged, proven design with highly accurate sensors having single-point calibration. The two-channel 512 controller displays fast and accurate measurements of both oxygen and hydrogen in a single compact instrument. Installation requirements are minimal, as is maintenance. Integrated temperature and pressure compensation, along with broad flow and measuring ranges, make the system easy to operate and maintain for years of reliable performance.

Recommended system components:

Component	Model	Description
Controller	512/AF0/P1C 1P000	H2 and O2 two-channel controller for nuclear services, including 4 alarms, 4 recorder current outputs, RS-45 serial output, and external pressure input
O_2 Sensor	A1100	Electro-Chemical oxygen sensor with Smart Capability: stainless steel, maximum pressure 100 bar
H_2 Sensor	31250GP	Thermal Conductivity hydrogen sensor with nitrogen purge
Pressure Sensor	28117	Pressure sensor
Flow Chamber	32002.01x	Multi-parameter flow chamber (holds two gas sensors and a pressure sensor)
Cables	325012	Sensor cables

HACH COMPANY
WORLD HEADQUARTERS
Telephone: (970) 669-3050
FAX: (970) 669-2932

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Call 800-227-4224
Contact the HACH office or distributor serving you.
www.hach.com techhelp@hach.com

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