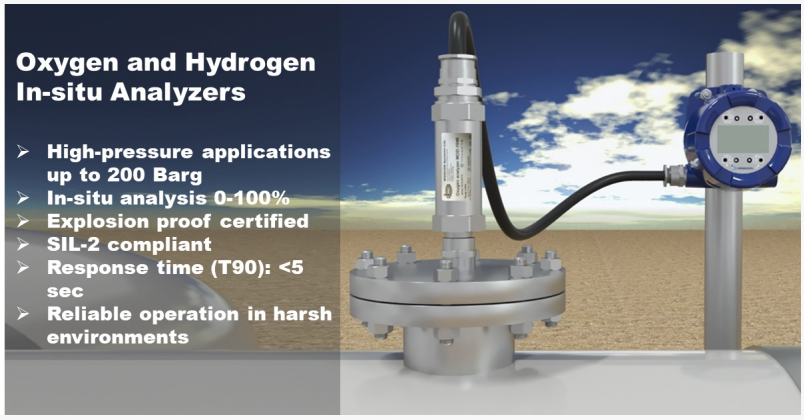
Modcon Solves Fundamental Challenge in Green Hydrogen Production

Breakthrough in real-time monitoring and intelligent process optimization unlocks safer more efficient high-pressure green hydrogen systems—without extraction.



LONDON, LONDON, UNITED KINGDOM, May 11, 2025 /EINPresswire.com/ -- The global race toward decarbonization hinges on reliable scalable green hydrogen production. Yet one of the most persistent challenges has been the lack of safe real-time control over gas composition at high pressures without relying on costly and hazardous gas extraction systems. Today, Modcon Systems Ltd. announces a paradigm-shifting solution that eliminates this bottleneck, coupling in-situ gas analyzers with AI-driven optimization frameworks to transform the future of clean hydrogen.

Modcon's breakthrough technology—its MOD-1040 Optical Oxygen Analyzer and MOD-1060 Thermal Conductivity Hydrogen Analyzer—allows for direct high-pressure measurement of oxygen and hydrogen inside electrolyzer systems, even in harsh environments containing potassium hydroxide (KOH) and water vapor, at pressures of up to 200 barg.

These analyzers are certified for use in ATEX / IECEx hazardous areas and SIL-2 safety integrity level.

Crucially, this hardware innovation is now fused with deep reinforcement learning (DRL) and fusion-based modeling enabling electrolyzer systems to dynamically optimize hydrogen production in real time—even under fluctuating renewable energy inputs and system degradation.

Green hydrogen production via electrolysis—powered by solar wind or hydroelectric sources—requires the separation of water into hydrogen and oxygen across an electrochemical cell. Key to system safety, efficiency and product purity is the ability to monitor gas composition at multiple sample points: anode outlet, cathode outlet, electrolyzer cell outlet, purification system and final storage. Traditional approaches to gas monitoring rely on sampling, pressure reduction and gas venting—raising safety concerns, increasing capital and operational costs and slowing response times. Sample extraction also risks contamination and may not accurately reflect real-time system dynamics.

The MOD-1040 Oxygen Analyzer utilizes quenched fluorescence optical technology delivering contact-free highly accurate in-situ monitoring of oxygen concentrations. It is particularly well-suited for harsh industrial environments with high pressure, temperature fluctuations and corrosive gases.

The MOD-1060 Hydrogen Analyzer leverages thermal conductivity principles ideal for binary gas mixtures such as hydrogen and air or oxygen. It is capable of measuring hydrogen concentrations continuously in real time and when paired with MOD-1040's oxygen readings allows for fusion-based compensation further enhancing the accuracy of hydrogen readings in complex gas matrices. By deploying these analyzers at strategic points within the electrolyzer and distribution system, operators can eliminate the need for hazardous sample handling systems while maintaining full control over process parameters.

To move beyond monitoring and into active process control, Modcon integrates its analyzer systems into AI-enabled optimization systems. Modcon.AI optimization software use deep reinforcement learning (DRL) models to analyze real-time sensor data and make intelligent adjustments to the electrolyzer's operating conditions. The DRL optimization framework includes state representation from real-time sensor inputs including oxygen and hydrogen concentrations, voltage, temperature, current density and system pressure. The action space comprises adjustable process variables such as input power levels, water feed rate and internal pressure modulation. The reward function is based on a multi-factor performance metric focused on maximizing efficiency, ensuring hydrogen purity, minimizing degradation and maintaining system stability.

By continuously learning from real-time operational data, the DRL system adapts to changing energy input conditions from solar or wind sources, electrolyzer wear-and-tear and gas

composition dynamics. This allows the system to self-optimize reducing energy consumption and extending equipment lifespan.

While the MOD-1060 excels in binary gas measurements, hydrogen systems often operate with varying gas mixtures. To address this, Modcon employs fusion modeling integrating data from both MOD-1040 and MOD-1060 analyzers within the DRL framework. This compensates for sample composition variations such as shifts in oxygen content or moisture by cross-validating hydrogen readings with independent oxygen data.

Hydrogen's significantly higher thermal conductivity compared to air makes it highly sensitive to composition changes. By embedding this physical knowledge into AI models, Modcon ensures robust accurate readings under any condition whether in the presence of nitrogen, oxygen or water vapor.

In addition to DRL, Modcon supports a hybrid modeling approach to optimize electrolyzer systems. Analytical models simulate polarization curves and identify thermodynamic limits. Empirical models use historical operational data for site-specific performance prediction. Mechanistic models employ electrochemical equations to simulate reaction dynamics. Machine learning models use large datasets to predict system degradation and performance shifts over time. This layered modeling framework enables Modcon to offer not just hardware but a complete digital twin platform for electrolyzer optimization.

By eliminating the need for sample extraction and introducing real-time AI-driven optimization, Modcon is setting a new standard for hydrogen production systems. Operators can now improve system efficiency and gas purity, extend electrolyzer lifespan, reduce CAPEX and OPEX, minimize environmental and safety risks and scale up green hydrogen projects with confidence.

"As the global demand for clean hydrogen surges, process intelligence and safety are no longer optional—they are foundational" said Gregory Shahnovsky CEO of Modcon Systems Ltd. "By uniting advanced sensors with intelligent control systems we're not just improving hydrogen production—we're making it economically and environmentally sustainable at scale."

About Modcon Systems Ltd.
Founded in 1972, Modcon Systems Ltd. is a pioneer in online process analyzers and real-time optimization technologies. The company develops in-situ sensors, AI frameworks and control systems for hydrogen and hydrocarbon industries supporting the transition toward a more sustainable industrial future.

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