DECARBONISING COMBUSTION IN STEAM METHANE REFORMERS

AT AMETEK, WE UNDERSTAND HOW TO REDUCE EMISSIONS SAFELY THROUGH OPTIMIZED COMBUSTION AND REAL-TIME PROCESS MONITORING

DECARBONISING THE STEAM REFORMING PROCESS

Widely used in the hydrocarbon processing industry, steam reforming faces increased regulatory scrutiny to reduce its carbon footprint and corresponding plant emissions. Operators must make hard choices to respond to these pressures. Carbon capture and alternative fuels show promise in reducing emissions and, while effective, they may also require sizeable investment and modification to equipment and infrastructure.

In the interim, operators of steam methane reformers (SMRs) may choose to focus on energy efficiency and increasing their yield output. They recognise the opportunity contained in their existing equipment through optimising the combustion process. In decarbonising, safety becomes key to increasing yield, improving fuel efficiency, and reducing emissions. Flue gas monitoring can be used to optimise the fuel/air ratio, while thermal imaging provides a greater picture of safe monitoring of the reformer operation – on the inside and at the outlet.

THE ROAD TO CO_2 INDUSTRIAL DECARBONISATION

ENERGY EFFICIENCY | ALTERNATIVE FUELS | CARBON CAPTURE

KEY STEPS TOWARDS A DECARBONISED FUTURE

If you want to improve your existing processes, or explore the potential for change, please speak to our experts.

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OPTIMISING COMBUSTION FOR GREATER EFFICIENCY & SAFETY

One way to reduce carbon dioxide (CO_2) emissions is by lowering the excess oxygen concentration in the flue gas, thereby reducing unneeded fuel consumption and heat losses through the stack. However, combustion optimisation requires careful monitoring of flue gas measurements to ensure sustainable efficiency and process safety.

Under perfect conditions, hydrocarbon fuels react to form CO_2 and water (H_2O). In practice, however, combustion is never perfect, and poor mixing causes the presence of partially burned hydrocarbons, called combustibles – usually in the form of ppm-levels of carbon monoxide (CO) and hydrogen (H_2).

Without enough oxygen, the level of combustibles will increase exponentially, reaching a breakthrough point and causing a potentially unsafe condition. This could be caused by a fuel leak or even a loss of the burner flame. Therefore the combustion process requires that the burner be operated with sufficient excess oxygen in the flue gas to ensure proper operation. However, measuring excess oxygen by itself does not tell the full story... and that is where additional measurements offer even more advantages to optimize combustion efficiency and safety.

Leveraging a combustibles measurement, operators have a secondary reference point to lower their combustion air levels at the burner. The combustibles measurement gives operators additional information to lower excess air levels safely – BEFORE reaching combustibles breakthrough. Lower excess air levels mean less fuel is consumed and fewer emissions are generated at the burner. This form of decarbonisation is known as “optimised combustion”.

To further monitor for safety, operators can also leverage a methane/hydrocarbon measurement as an additional safeguard to detect unburnt fuels, process tube leaks, and loss of flame during start-up and normal operation.

Overall, operators can safely decarbonise their steam methane reformers through optimized combustion by the careful monitoring of their excess oxygen, combustibles, and methane concentrations.

MEASURING OXYGEN ALONE DOES NOT TELL THE FULL STORY... MEASURING COMBUSTIBLES AND METHANE IN THE FLUE GAS ALSO PLAYS TWO VERY IMPORTANT ROLES: SAFETY MONITORING AND PROCESS EFFICIENCY.

INCREASING SAFETY & EFFICIENCY THROUGH TUBE WALL TEMPERATURE MONITORING

Understanding the tube wall temperature (TWT) within the reformer is critical to controlling the reforming reaction and ensuring safe operation of critical assets. Excessive TWT significantly shortens the lifespan of the tubes. Finding a balanced temperature that does not place undue stress on the tubes, while being high enough to deliver the most efficient process, is critical to the efficiency and profitability of a plant.

Having to rebuild a 400-tube reformer can cost millions in materials alone, not to mention the impact of lost production. Unsurprisingly, many plants err on the side of caution when setting operating temperatures, to reduce the risk of this expensive tube damage. However, if the plant is run too conservatively, it will not achieve maximum efficiency, increasing both cost and CO_2 emissions. A reduction of 10 °C (18 °F) below the design temperature, for example, results in a 1% productivity loss that may translate to millions of dollars in sales; in regions subject to carbon taxes, the increased emissions will also result in higher taxation.

It is, therefore, critical to find and maintain the optimum temperature to deliver production efficiency while preventing damage to the tubes. TWT measurements can also be used to ensure balanced firing within the furnace, with all tubes running to the same exit conditions. Obtaining accurate TWTs presents several measurement challenges. The conditions are extremely hot and hazardous, with flue gases at the outer tube surfaces reaching approximately 960 °C (1760 °F). Inner-surface process gases can range from 450 to 900 °C (842 to 1652 °F).

Significant experience is needed to measure tube temperatures manually and to fully understand the interplay between the reformer construction, process flow, heat transfer principles, background radiation, emissivity, and the inherent cooling effects that occur whenever the furnace peephole is opened.

With increasing plant reliability, there is a longer gap between serious problems, so operators are often unfamiliar with how to spot developing issues and deal with them. However, by implementing thermal imaging with their SMRs, operators have the sure-fire visibility to extend tube life safely and optimize flue gas temperatures – even at lower excess oxygen levels.

HOW WE CAN HELP

We understand the challenges of reducing combustion emissions safely while increasing product yield. Through combustion monitoring and thermal imaging, your plant can achieve safety and efficiency to meet your environmental and decarbonisation goals.

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THERMOX WDG-V

Designed for safety and reliability, this flue gas analyser is designed to optimise combustion control and process safety through the measurements of excess oxygen, combustibles, and methane / hydrocarbons. The WDG-V mounts directly to the process flange using a close-coupled extractive design, and delivers fast responses in flue gases up to 1648 °C (3000 °F). Certified SIL-2 capable, the WDG-V also leverages built-in redundancies and predictive diagnostics to ensure high safety availability.

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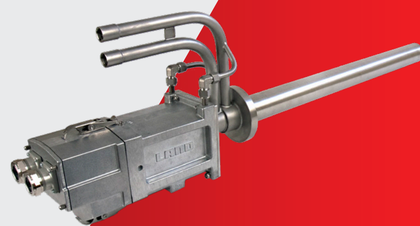
NIR-B / MWIR-B

Our recommended solution for thermal imaging in SMRs is either the Near Infrared Borescope (NIR-B) or Mid-Wave Infrared Borescope (MWIR-B) radiometric infrared borescope imaging cameras, which measure temperatures in the range of 300 to 1800 °C (572 to 3272 °F) and utilize the latest wide dynamic range imaging technology. They deliver a high-resolution thermal image with continuous, highly accurate temperature measurements of both the tube and refractory wall surface. We have also developed a Portable Furnace Thermal Imaging System with optional air-cooling, that enables regular, easy, and quick inspections.



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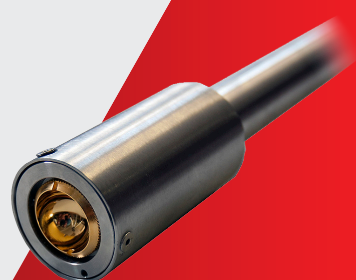
GOLD CUP

Periodic reference measurements are required to verify the accuracy of the temperature data produced. This water-cooled three-metre-long probe creates near black body conditions at the measurement point, ensuring repeatable, reliable reference temperatures. If the environment has a hotter background – usually the case in an SMR – compensation for both surface emissivity and incident radiation is needed to ensure accurate non-contact infrared measurements.



Working together, these products allow you to improve yield, decrease CO_2 emissions, and increase operational safety within your steam methane reformer.

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