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Boiler SCR Technology: A Pivotal Step Toward Environmental Sustainability

SCR technology offers improved operating efficiency and lower emissions.

By Chelsey Ryker



FIGURE 1. A 110,000-pound-per-hour package watertube rental boiler and CataStak™ SCR for single-digit NO_x compliance (left) and a 350-hp package firetube boiler with proven 2 ½ ppm ultra-low NO_x burner (right). *Image courtesy of Nationwide Boiler*

Emission regulations for combustion systems have been in place for more than half a century, and in the 1990s, the Clean Air Act put a spotlight on emissions specifically from industrial boilers. Boiler owners were required to retrofit or replace equipment that did not meet the new limits set for emissions of nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), and sulfur dioxide (SO₂). While low-NO_x burner technology was one option that addressed NO_x reduction, these

burners had limitations, including the ability to handle load swings and maintain flame stability. With evolving requirements in areas such as California, burners alone were not able to reliably accomplish the single-digit NO_x emissions performance, so alternative, “back-end,” solutions were explored.

Focusing on environmentally sustainable solutions is something we are all very familiar with today and, while the focus has shifted to reducing our carbon footprint, NO_x emission limits in some areas have reached an all-time low of 2 ½

ppmvd at 3% O₂. Although there are more reliable ultra-low NO_x burner solutions available now, that was not the case back in the 90s. The solution in the years that followed the Clean Air Act was, and still is, selective catalytic reduction (SCR).

Nationwide Boiler developed the CataStak™ SCR to address stringent emissions regulations specifically for its fleet of package watertube rental boilers, and, eventually, they applied the technology to permanent boilers, gas turbines, and other fired equipment applications. The CataStak is a post-combustion

SCR system proven to achieve reliable, ultra-low, single-digit NO_x performance, providing both economical and practical benefits to users through improved operating efficiency and lower emissions. Additionally, the CataStak provides a reasonable return on investment and often exceeds emission limits beyond what is required. With the ability to reduce NO_x, CO, and volatile organic compounds (VOCs), the CataStak was a pivotal step toward sustainable steam solutions for the boiler industry.

Larry Day, president and CEO, Nationwide Boiler, drove the integration of such back-end solutions into the company's fleet of rental boilers. The objective was clear: to develop an SCR system that would reliably meet and exceed current and future emission limits without compromising critical boiler functionalities. Known today as the CataStak, Nationwide Boiler started off as a user operating these SCRs across its fleet of rental boilers. The CataStak was proven to offer dependable performance through experience, testing as low as 1 ppm NO_x, time and time again, before it was ever applied to permanent applications.

In one case study, the CataStak reduced NO_x emissions to less than 1 ppm NO_x and resulted in an energy efficiency rebate of almost \$300,000 for a prominent food processing facility in California. The end user purchased a new Babcock and Wilcox 50,000-pound-per-hour, 275-psi boiler equipped with a standard 30-ppm, low-NO_x burner; a CataStak SCR system; an EconoStak fuel economizer; and a condensing economizer. Once installed and commissioned, it was certified to operate at better than 95% fuel-to-steam efficiency with less than 1-ppm NO_x emissions.

Rather than utilizing a more expensive and complex ultra-low NO_x burner with an oversized forced draft (FD) fan, the CataStak proved to be the ideal solution for reducing NO_x emissions economically, efficiently, and with minimal operator intervention. With more than 250 installations across the country, the CataStak was an

early innovation and just one step toward a more sustainable future for steam production.

NO_x Reduction Today

In addition to SCR technology, now there are more reliable, ultra-low NO_x burners that address single-digit NO_x limits as low as 2 ½ ppmvd at 3% O₂. Some of these burners utilize flue gas recirculation (FGR) and higher gas delivery pressures, while others achieve 2 ½ ppm with lower residual O₂, normal gas delivery pressures, and no need for FGR.

The 2 ½ ppm burner solution is currently only available for firetube boiler applications.

Proven Technologies Reapplied for Decarbonization

With today's focus geared toward the reduction of carbon and other greenhouse gas emissions, there are numerous proven technologies that are being reapplied for decarbonization efforts. Fossil fuel alternatives provide one sustainable approach to steam and energy production, and this presents options, like hydrogen, biofuels, and electricity sourced from renewable outlets.

Burners have been successfully fired on hydrogen and biofuels for more than 50 years, and these fuels are proven to be viable, carbonless options for industrial steam production. The limiting factor, however, is hydrogen supply and the production of green hydrogen. Green hydrogen hubs, or networks of hydrogen producers, consumers, and local infrastructure, are currently being developed and are intended to accelerate the use of hydrogen as a clean energy carrier. Once these hubs are in place and hydrogen is more readily available, it will likely gain even more traction in industrial boiler applications. One challenge of hydrogen firing is the increase in NO_x production but, as covered previously, an SCR can be installed to reduce the increase of NO_x output.

Leveraging electricity as an alternative, electric boilers offer a clean, controllable, and highly efficient means of generating

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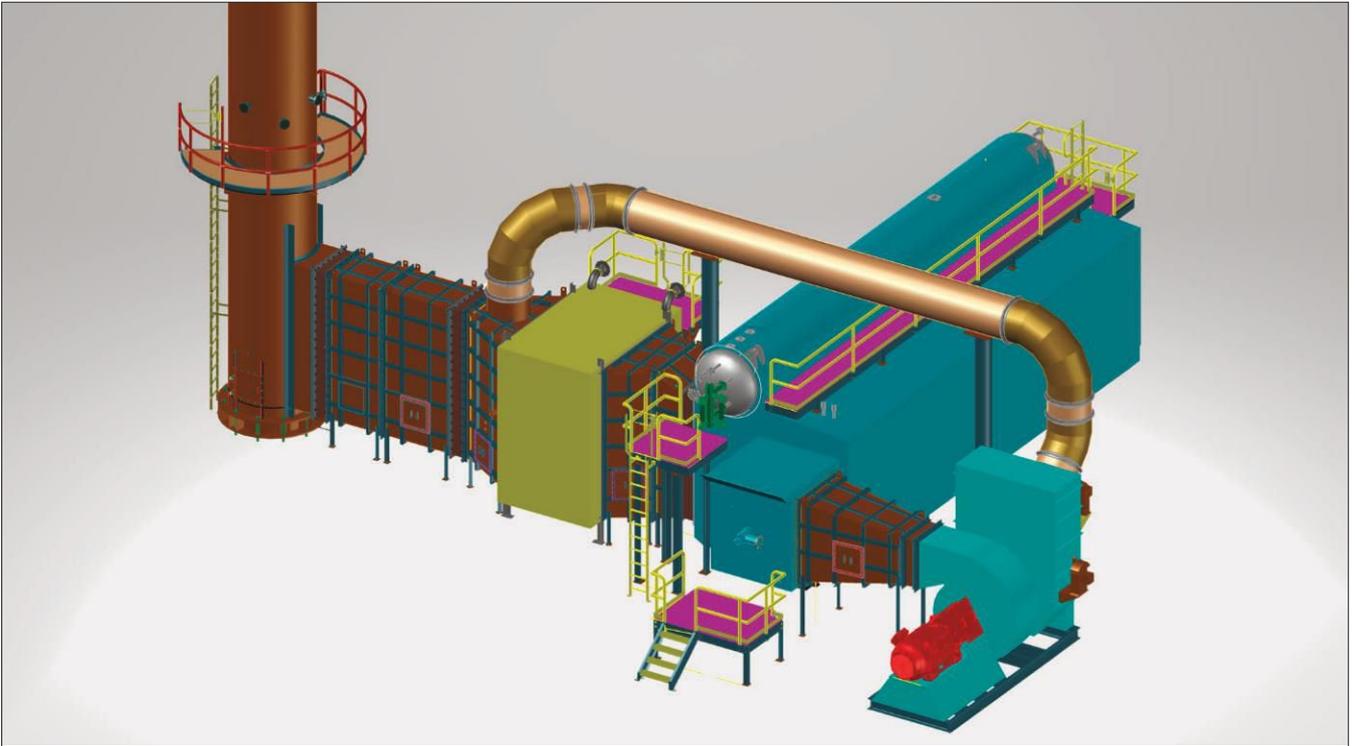


FIGURE 2. A 200,000-pound-per-hour package watertube boiler designed for firing on a hydrogen-blend fuel.
Courtesy of Nationwide Boiler



FIGURE 3. Oilon's 30,000-300,000 kW Chillheat industrial heat pump solution.
Photo courtesy of Oilon

high-pressure steam, boasting an impressive 99% conversion of energy input. This method showcases zero emissions, which is especially advantageous for industrial sites with the necessary electricity infrastructure required to support such boilers. Electric boilers have been around for decades and, most notably, can be found in locations like Quebec, Ontario, and British Columbia due to an electrical grid based mostly on

hydro, nuclear, or other non-fossil fuel energy sources.

Lastly, we have heat pumps as a sustainable option that supports steam production. While initially geared for HVAC, heat pumps are gaining traction in industrial applications as technology advances. Prepackaged heat pumps are not currently capable of producing high-pressure steam, but they can contribute to industrial processes by providing heat up to 240°F. Driven

by electricity, it is a carbonless solution with the added benefit of energy efficiency. A heat pump uses approximately one-third of the energy compared to traditional electric or fossil fuel heat-generating equipment for the same temperature increase. In fact, a heat pump can typically move three to four times the amount of energy it consumes.

A Continued Focus on Sustainability

As emission reductions and decarbonization continue to be an important part of our global sustainability efforts, the industry needs reliable products that not only ensure compliance but also drive sustainability and operational efficiency. Innovations, like the CataStak and ultra-low NO_x burners, as well as proven technologies, like hydrogen firing and heat pumps, reflect a forward-thinking approach. This aligns with the industry's pursuit of efficient, sustainable, and economically viable solutions. **TB**

By Chelsey Ryker, marketing manager, Nationwide Boiler