industry: energy and environmental technologies

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A Fresh Look at Accelerating Electrification and the Role that Thermal Plays

Summary:

The goals of the 2015 Paris Agreement are now playing out, with companies and governments making drastic changes to hit its ambitious targets. While investment in clean energy is a huge part of these changes, it must go hand-in-hand with the further electrification of industrial processes. Even in the oil and gas industry itself, there is significant room for electrification and decarbonization, particularly when it comes to thermal applications (process heating). Innovative technologies have solved many of the challenges that previously hindered implementation of electric process heating, making it an obvious area on which companies should next focus their efforts.

On May 26, 2021, a Dutch court ruled that Royal Dutch Shell had to dramatically reduce its carbon emissions by 45% compared to 2019 levels. What made this a landmark case was that it was the first time this, or any other company, has been legally obliged to align its practices and policies with the Paris climate accord. It is widely believed that more will follow.

That legal precedent was not a sign of things to come, so much as a capstone on what is already a reality. The pressure to address climate change has been mounting for decades, and it has not come from one organization, court case or treaty. Change has been occurring at local, national and international levels, across government, industry, finance and non-profits. (For a bit of this history, see our article "***Decarbonization, electrification and the case for modern electric process heaters***.") The challenge that many organizations face is not a cultural one of convincing people that change is needed, but a practical one: How can we realistically hit ambitious climate change targets?

The energy sector has been a part of this change, too. The oil and gas industry (including LNG) has been embracing efforts to reduce carbon emissions in their own processing, moving toward "decarbonization and electrification." Even as producers of traditional fossil fuels, these companies have recognized the need to reduce their own carbon footprints, and so as they continue to process and distribute fossil fuels for the world's energy consumption, they are limiting their own use of them.

But just because there is a succinct word or phrase for the process does not mean it is easy to understand, much less design practical processes around. In the experiences of our own engineers, we have come to believe that the electrification of thermal processes will play a key role in the decarbonization of the energy sector.

The Paris Climate Conference Goals and IEA Report

The catalyst for the recent wave of changes with regard to climate policy was the 2015 Paris Climate Conference, which resulted in the Paris Agreement. The agreement set the ambitious goal of keeping global temperature rise contained to two degrees Celsius above pre-industrial levels, and to set in motion efforts to keep that temperature increase even lower (1.5 degrees Celsius). The agreement also contained measures for the monitoring, verification and reporting of progress toward those targets.

Fast-forward to May of 2021, when the International Energy Agency (IEA) released a new report detailing the steps needed to achieve net-zero carbon emissions (NZE) by 2050, a necessary step if there is to be any hope of hitting the Paris Agreement targets. The report sets some 400 milestones and boasts that these can be met while "ensuring stable and affordable energy supplies, providing universal energy access and enabling robust economic growth." But the report also included steps such as ceasing new construction of coal and oil power plants, phasing out unabated ones by 2040 and calling an end to investment in fossil fuels. Meanwhile, electricity generated from clean energy sources such as solar and wind is to play a "key role" across all sectors.

While the reaction to the IEA report has been mixed, it is clear that organizations are working hard to envision themselves in the picture that the IEA has painted of the future. For example, the Qatar-based trade organization

Gas Exporting Countries Forum (GECF) agreed on the need to attain NZE, but also re-emphasized their belief that natural gas still has a central role to play in energy transition, especially as developing countries move away from coal-fired plants. They also added that oil and gas companies can help develop clean energy technologies (such as low-carbon hydrogen, biofuels and offshore wind) at scale.

Decarbonizing Fossil Fuels Processing

According to a 2018 report by McKinsey & Company, a full nine percent of global emissions were due to either direct or indirect emissions from oil and gas operations alone. It should not be surprising, then, that a major part of their decarbonization efforts have revolved around electrification of their own processes. In switching to all-electric or mostly-electric processes, these companies can reduce emissions by powering their plants with clean, renewable energy sources. Indeed, many major players are themselves building or investing in solar and offshore wind plants.

It is still an open question as to where in a process companies should start looking to make changes. Process heating is one obvious area. A 2016 report by the Joint Institute for Strategic Energy Analysis (and commissioned by the U.S. Department of Energy) looked at the consumption of combustion energy nationwide and found that, across 14 industries, process heating was responsible (on average) for 24% of that energy consumption. The report also indicated that gas-fired process heaters could and should be replaced by “cleaner” heat exchangers.

Switching to electric process heaters has its own challenges, of course. For example:

- **Electric heaters will need to be able to accommodate the larger wattage and amperage required to hit specific temperature requirements.**
- **Adequate control of the heater is needed to ensure that processes can be performed safely.**
- **Coking/fouling must still be addressed.**

The newest generation of electric heaters is meeting these challenges head-on, and so they are quickly becoming a cost-effective and safe way to bring further electrification to industry processes. Some of those innovations include:

Higher Watt Densities

Newer technologies incorporated into electric heat exchangers allow for designs that take advantage of increased heat flux—i.e. watt density—for a given gas composition and a set of application conditions. Higher watt densities can help make processes more efficient and less costly while still meeting critical temperature requirements, reducing overall footprint and providing for safer operation.

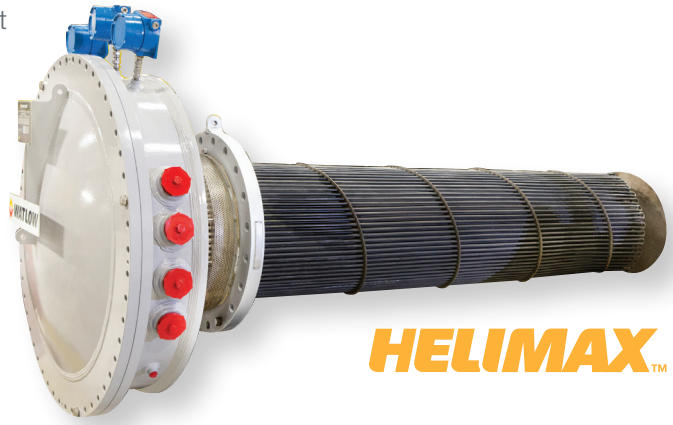
Modern Control Systems

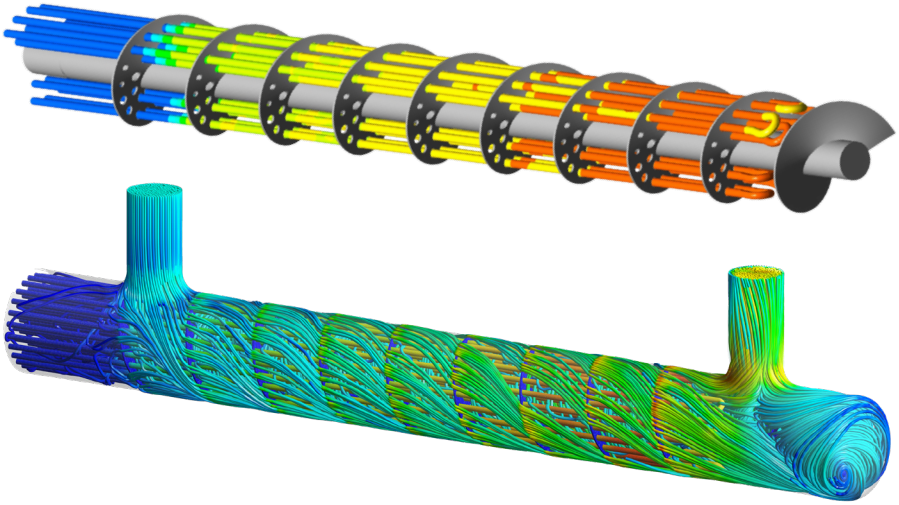
Matching the appropriate temperature control system to heater, material and process is critical for both safety and the longevity of the heater. Ideally, two separate control systems should be used: One for process temperature control and one for high limit control. PID-type process temperature controllers, in particular, offer more stable control and faster response than ON/OFF switching controls or thermostats. Given how quickly an event can escalate in a typical industrial process, it pays to have fast, reliable control systems designed for the electric heat exchanger in question.

Continuous Helical Flow Technology™

Coking/fouling is often a direct effect of “hot spots” in a process heater created by dead zones (areas with little-to-no flow), and that subsequently degrade the material. This happens often when segmented baffles are used to introduce turbulent flow. The resulting fouling requires further maintenance and downtime (planned and unplanned) to clean the heater.

Heaters with Continuous Helical Flow Technology™, on the other hand, do not have these dead zones, which means a much more uniform temperature is achieved across the heating surface. Material is always in motion and does not have time to collect and degrade. The result is near-elimination of fouling. Heaters with this technology, like our own HELIMAX™, also have a much smaller footprint, allowing for a more efficient use of space.





CHF™
Continuous Helical Flow Technology

Fully developed flow pattern

Takeaways

Companies in the energy sector, including oil and gas, have been taking bold steps to reduce their overall carbon footprint by electrifying their processes. Switching to electric process heaters is a key step in this process that will provide other benefits as well. Modern electric heaters with advanced fluid dynamics, Continuous Helical Flow Technology, higher watt densities and best-in-class control systems resolve many of the traditional challenges with electric heating while allowing companies to hit their electrification goals.