A CLEAN FUTURE POWERED BY HYDROGEN

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ABSTRACT

In today's world, we are facing an increasing pressure to take action to temper climate change. Think about the growing public support for climate supporting measures, or the commitment of the European Community to reduce CO_2 emission by 40% in 2030 and even to become carbon neutral in 2050.

Globally we emit about 35 billion tons of CO_2 each year. Approximately 70% is generated by coal or oil combustion in transportation and in power generating plants. Around 25% is emitted by thermal appliances in a wide variety of applications in the manufacturing industry and in commercial heating. Most of these thermal appliances are natural gas fired (+/- 90%), only a small part is light oil fired. Thermal appliances in the process industry is the sweet spot of the core activities of Honeywell Thermal Solutions.

Green hydrogen

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Hydrogen produced with renewable energy like wind and solar is definitely the most promising technology for clean combustion: no CO_2 is emitted during the hydrogen production process. The combustion of hydrogen in the thermal appliance will only result in heat and pure water in the flue gas. Clearly this technology is the way forward to reduce or even omit the production of CO_2.

Here is an example: a 7.5 MW burner is running in a continuous process (24h/day) at its maximum capacity. When switching the fuel of this burner from natural gas to hydrogen, a massive 35 tons of CO_2 emissions will be avoided each day.

What we expect for the coming years is an ongoing trend from coal and oil-fired power plants to renewable forms of energy such as wind and solar power. Because of the unpredictable fluctuations of these natural energy sources, we will be faced with a growing challenge to match energy generation and demand. The beauty of hydrogen lays in the fact it can act very well as an energy buffer since several new technologies have been developed to transport and store hydrogen in recent years. Moreover, in the next decade we expect the price of hydrogen will become more in line with that of natural gas, making it even more attractive.

In the first instance, the hydrogen that will become available will be mixed into the existing natural gas distribution network with levels between 10% to 20% and will be used in transport and all kinds of industrial, commercial and residential heating applications. Global studies show the real shift in industry will start with high temperature applications in steel and metals between 2025 and 2030 followed by the lower temperature applications between 2030 and 2035. Meanwhile, over the next 5 years we expect several pilot projects in both high and low temperature industrial applications. Honeywell Thermal Solutions is well positioned to be the pioneer in these clean, hydrogen-fired projects.

Honeywell’s hydrogen offering

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Honeywell has an extensive portfolio to serve the enormous variety of applications in the thermal process industry. From food processing, to glass production, from paint drying to waste incineration, all imaginable markets where heat is required are served by the Honeywell Thermal Solutions (HTS) division of Honeywell.

HTS manufactures an extensive range of burners and fuel delivery equipment to safely control the fuel supply. These includes safety shut off valves and flow control and monitoring equipment and electronics to control and monitor the entire combustion system.

The HTS team can design, manufacture and service a complete burner system in which the individual components are carefully selected, assembled and pretested to make the burner perform ideally in the particular application.

The majority of the HTS burners (Eclipse, Kromschröder, Hauck, Maxon) are capable of firing up to 100% hydrogen and are supported with state-of-the-art control and safety products which are suitable for hydrogen, as well.

The effect of hydrogen on your application

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Knowing a burner can fire safely and reliably on hydrogen is one thing, knowing the effect on the application is another! When firing a burner on hydrogen the flame aspect will be different compared to the same burner firing on natural gas. The difference in flammability, speed of the combustion reaction, flame luminosity, flame length and changes in the flue gas composition will all have an effect on the process. It will have an impact on how the product is heated and how the combustion chamber or oven need to be constructed. Extensive testing in the HTS R&D labs on different burners have shown that one cannot predict the effect on the flame by simply taking theoretical assumptions. There are many factors which will finally influence the flame aspect which in some cases are counterintuitive to what may have been expected on theoretical grounds.

Therefore, it is important to test fire the burners on hydrogen and make sure critical parts such as mixing plates or mixing cones and gas nozzle material and ports are such that the hydrogen combustion remains stable and safe without overheating or even destroying parts of the equipment.

For detailed information on particular burners and their capabilities, contact your Honeywell Sales Engineer or fill in the form available here: ThermalSolutions.Honeywell.com/ZeroCarbon

Computational Fluid Dynamics

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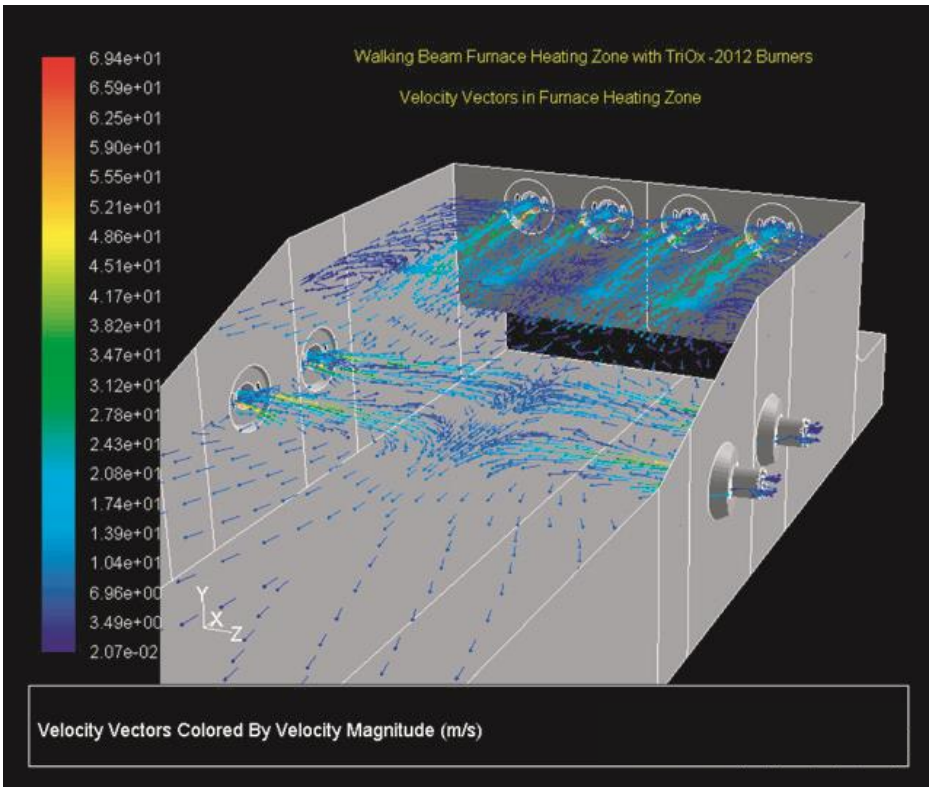
The application engineering team within HTS uses top-end CFD software which can simulate flames and their effect on air streams for different types of gas. This capability allows the team to predict how varying fuel content will affect the environment downstream of the burner in the process. Backed up with real live measurements in the R&D labs, this CFD capability is a powerful tool when used in combination with the know-how and experience of the Honeywell combustion specialists.



Conclusions

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There is a consensus between the scientific and economic community that hydrogen is the ideal energy carrier to move to a carbon neutral future whilst not sacrificing on flexibility, safety, efficiency and performance of residential and industrial energy consumers. The turning point for a full hydrogen switch will depend on the evolution of the production cost and may not be widely available for some time. Nevertheless, the technological developments are already ongoing with equipment manufacturers preparing their components and machinery to adopt the use of hydrogen. Furthermore, some early adopters in industrial environments are starting pilot projects running on hydrogen already today.

Honeywell Thermal Solutions is leading the way for a green hydrogen future with adapted equipment and is supporting its customers who are planning to transition from traditional carbon fuel to partial or full hydrogen.

Case Study: Honeywell reduces cogeneration plant emissions by switching to hydrogen fuel

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When a global chemical customer wanted to refit its longstanding gas turbine and steam boiler cogeneration system to run on hydrogen power, it turned to Honeywell for assistance.

The conversion opportunity arose when the customer was approached to purchase an ongoing supply of hydrogen at low cost. Spotting an opportunity to achieve cleaner operations and reduce carbon footprint, an agreement was soon reached.

However, there was a challenge: the hydrogen supply wasn't constant. During peak production, the supply could be sufficient to run the entire installation on hydrogen, but equally, there could be periods when no hydrogen was available.

The solution? To build flexibility into the system by allowing it to run on 100% natural gas, 100% hydrogen, or any mixture of the two. At the same time, the customer wanted the conversion performed with little or no system re-adjustments, mechanical changes or safety setting changes.

Honeywell—which helped to design the original cogeneration system—was brought back in to manage the conversion. It began by implementing an additional fuel train to safeguard the hydrogen supply. Among other control equipment, Honeywell Maxon safety shut off valves were used to connect the hydrogen supply and mix it with the natural gas line upstream of the burners.

Finally, Maxon Series HC AIRFLO® low NO_x burners were deployed to seamlessly accommodate both natural gas and hydrogen, with no changes required to the gas nozzles or mixing plates.

With the project objectives thus achieved, today the chemical customer is realizing the environmental, performance, and cost benefits of its hydrogen energy supply.

Appendix: The physical characteristics of hydrogen

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- H_2 is the first and lightest element in the periodic table, consisting of one proton and one electron.
- H_2 is a colorless and tasteless, non-toxic gas
- H_2 is 8 times lighter than natural gas, but it burns 8 times faster – shorter flames, increased temperature of nozzles
- H_2 heats up when reducing pressures, unlike natural gas and other carbon fuels
- The spark energy required to ignite H_2 is 15x lower compared to carbon fuels
- The Wobbe index is close to natural gas
- Very wide flammability range compared to natural gas
    - Natural Gas: flammable between 4 and 16 vol% gas in the gas/air mixture
    - Hydrogen: flammable between 4 to 77 vol% H_2 in the hydrogen/air mixture
- When switching from natural gas to hydrogen, the pressure drops in the system need to be corrected to maintain the same energy output. Important here is to note whether we want to maintain the high heating value output or low heating value output:

	CH_4	H_2	Ratio	Correction factor pressure differential Ratio² x (density H_2 / density CH_4)
Density (kg/Nm³)	0.71	0.09		
HHV (kW/Nm³)	11.06	3.54	3.12	1.24
LHV (kW/Nm³)	9.97	2.99	3.33	1.41

For More Information

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