BURNERS, COMBUSTION AND HEAT TRANSFER

(577) - FIRING HYDROGEN IN PROCESS BURNERS

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Interest in hydrogen as a fuel continues to grow because it produces no CO_2 when combusted and because of shrinking fossil fuel supplies. While hydrogen is not a renewable fuel, it can be made from renewable energy sources such as solar, wind, and hydroelectric, which would make it a “green” fuel.

Process burners in refinery and petrochemical applications typically fire on fuels generated during the production of, for example, gasoline, diesel, and jet fuel. Those fuels have a wide range of compositions that change as the plant’s product mix changes. Fuels also change from startup to normal operation. A challenging aspect of process burner design is the need to safely handle any fuels, while minimizing pollution emissions and maximizing thermal efficiency for the “design” fuels.

Hydrogen has many unique characteristics compared to typical hydrocarbons such as a higher adiabatic flame temperature (AFT), wider flammability range, higher flame speed, higher ignition temperature, lower volumetric heating value, and lower combustion air requirements. Changing fuels from ones containing little if any hydrogen to high hydrogen fuels must be carefully analyzed because of potential issues. For, example if a high hydrogen fuel is used with tips designed for natural gas, there could be an issue with increased fuel pressure. For some fuels, this increased pressure could lead to flame lifting. Fortunately, hydrogen has a high flame speed that can offset this potential lifting problem. Another potential problem using high hydrogen fuels is flashback in premix burners which is much more likely for hydrogen compared to other fuels, due to hydrogen’s high flame speed.

There are several dynamics that make switching to hydrogen particularly challenging. The first is when there are large fuel composition changes, ranging from a startup fuel like natural gas which typically contains no H_2, up to high H_2. Since the fuel injector holes are a fixed size and hydrogen requires a much higher volumetric flow compared to other fuels for a given firing rate, the fuel pressure using hydrogen will be higher. Most process heaters are natural draft with manually-operated burner air registers. Burners are not typically automatically adjusted because of the added cost and complexity. Given that reality, another potential challenge is an operational issue because hydrogen requires significantly less combustion air than other fuels. If the air registers are not adjusted when going to high hydrogen fuels, there would be much more combustion air than needed. In that case, pollution emissions, thermal efficiency, and production could be detrimentally affected.

This paper will discuss the many considerations of using high hydrogen fuels in process burners including a case study. For example, NOx emissions might be expected to increase using hydrogen because of its higher AFT. However, its higher exit velocity combined with wider flammability limits, permits more furnace gas entrainment which lowers NOx. If done correctly, that can mitigate the higher AFT effect on NOx. Switching from conventional fuels to high hydrogen fuels must be done properly to ensure production, efficiency, and emissions are not adversely affected.

Palavras-chave : hydrogen;process burners;fired heaters