An Experimental Determination of the Limiting Factors Governing the Operation of High-Hydrogen Blends in Domestic Appliances Designed to Burn Natural Gas

Authors : Haiqin Zhou, Robin Irons

Abstract : The introduction of hydrogen into local networks may, in many cases, require the initial operation of those systems on natural gas/hydrogen blends, either because of a lack of sufficient hydrogen to allow a 100% conversion or because existing infrastructure imposes limitations on the % hydrogen that can be burned before the end-use technologies are replaced. In many systems, the largest number of end-use technologies are small-scale but numerous appliances used for domestic and industrial heating and cooking. In such a scenario, it is important to understand exactly how much hydrogen can be introduced into these appliances before their performance becomes unacceptable and what imposes that limitation. This study seeks to explore a range of significantly higher hydrogen blends and a broad range of factors that might limit operability or environmental acceptability. We will present tests from a burner designed for space heating and optimized for natural gas as an increasing % of hydrogen blends (increasing from 25%) were burned and explore the range of parameters that might govern the acceptability of operation. These include gaseous emissions (particularly NOx and unburned carbon), temperature, flame length, stability and general operational acceptability. Results will show emissions, Temperature, and flame length as a function of thermal load and percentage of hydrogen in the blend. The relevant application and regulation will ultimately determine the acceptability of these values, so it is important to understand the full operational envelope of the burners in question through the sort of extensive parametric testing we have carried out. The present dataset should represent a useful data source for designers interested in exploring appliance operability. In addition to this, we present data on two factors that may be absolutes in determining allowable hydrogen percentages. The first of these is flame blowback. Our results show that, for our system, the threshold between acceptable and unacceptable performance lies between 60 and 65% mol% hydrogen. Another factor that may limit operation, and which would be important in domestic applications, is the acoustic performance of these burners. We will describe a range of operational conditions in which hydrogen blend burners produce a loud and invasive ‘screech’. It will be important for equipment designers and users to find ways to avoid this or mitigate it if performance is to be deemed acceptable.

Keywords : blends, operational, domestic appliances, future system operation.
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