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HYDROGEN-ENRICHED NATURAL GAS (HENG) IN THE HOME: THE EFFECTS OF HYDROGEN ADDITION ON THE STABILITY, PERFORMANCE AND RUNNING COST OF DOMESTIC APPLIANCES

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With levels of atmospheric carbon dioxide exceeding 400 ppm for the first time, it is becoming increasingly vital to implement a low-carbon strategy in all avenues of daily life. To this end, there has been significant recent interest in the domestic use of hydrogen-enriched natural gas (HENG), in place of the conventional natural gas currently used in businesses and homes. Due to the disparate properties of hydrogen and natural gas, however, it is not possible to incorporate too high a percentage of hydrogen into the supply without a major overhaul of existing end-use appliances; for this reason, our study explores the maximum proportion of hydrogen in HENG which may be achieved within the present-day infrastructure. A meta-analysis of existing combustion models has been conducted to determine the maximum theoretical percentage of hydrogen in HENG that is compatible with typical contemporary natural gas appliances. The stability of a burner is tested experimentally using varying HENG composition and air-to-fuel ratio, in addition to changing the diameter of the burner ports. A theoretical maximum of approximately 35 mol% was predicted for the proportion of hydrogen in HENG; above this value, flash-back was expected to occur during extinction of the flame. Flame stability was demonstrated experimentally for hydrogen percentages approaching this predicted limit, even in the case of atypically large port diameters of more than 2 mm. Having verified the limits of HENG composition to ensure safe, effective and reliable appliance operation, the possibility of a real world adoption of HENG in place of natural gas has been demonstrated. The benefits of such a changeover are expected to be significant; supplying houses with HENG fuel contains 30 mol% hydrogen, for instance, would decrease household carbon dioxide emissions by an estimated 11-18%.

Recent Publications

1. **Jones D R, Al-Masry W A and Dunnill C W (2018) Hydrogen-enriched natural gas as a domestic fuel: An analysis based on flash-back and blow-off limits for domestic natural gas appliances within the UK. Sustainable Energy & Fuels 2:710-723.**
2. **De Vries H, Mokhov A V and Levinsky H B (2017) The impact of natural gas/hydrogen mixtures on the performance of end-use equipment: Interchangeability analysis for domestic appliances. Applied Energy 208:1007-1019.**
3. **Linan A, Vera M and Sanchez A L (2015) Ignition, liftoff, and extinction of gaseous diffusion flames. Annual Review of Fluid Mechanics 47:293-314.**
4. **Kalantari A and McDonell V (2017) Boundary layer flashback of non- swirling premixed flames: Mechanisms, fundamental research, and recent advances. Progress in Energy and Combustion Science 61:249-292.**
5. **Okafor E C, Hayakawa A, Nagano Y and Kitagawa T (2014) Effects of hydrogen concentration on premixed laminar flames of hydrogen-methane-air. International Journal of Hydrogen Energy 39:2409-2417.**

Biography

Daniel R Jones is working as Senior Lecturer for Swansea University His international experience includes various programs, contributions and participation in different countries for diverse fields of study. His research interests reflect in his wide range of publications in various national and international journals.

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