MAGNETIC FORCES INFLUENCING SOOT AND EMISSION IN LAMINAR DIFFUSION FLAMES

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A major issue in combustion science is soot production control. Soot not only represents combustion inefficiency, but also a hazard to human health [1].
To control soot production, current strategies involve post-treatment methods, such as the usage of filters [2] and/or catalysts [3]. Increasingly promising methods are in-situ strategies, such as the design of new fuels [4], exhaust gas addition [5] or electrical fields [6]. Here, we assess the feasibility of an in-situ strategy using magnetic fields.
The method is based on the relatively high paramagnetic susceptibility of O2. As studied by Shinoda et al. [7] the flow conditions of a flame are affected by the spatial evolution of the magnetic field.
In this study, a non-smoking, laminar ethylene-air diffusion flame was established over an axisymmetric Santoro type burner and settled into an electromagnet. The electromagnet consisted of a pair of coils similar to the Helmholtz configuration. The flame experienced different magnitudes of upward magnetic square gradients (0 to 5.9 T^2/m) that depended on the electrical current through the coils. Flame emission was captured by a photodiode and a high resolution camera. Emissions can be correlated qualitatively to the flame temperature. Soot volume fraction measurements were performed by Laser-Extinction-Method (LEM) [8]. An increasing soot volume fraction was evident with increasing magnetic gradient [9]. Observations suggest that light captured by the photodiode was reduced and a thinner, longer flame with increasing magnetic gradient was visible. We conclude that a reduction of emission intensity is correlated to a decrease in flame temperature, suggesting that increasing the magnetic gradient cools the flame down.

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