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Experimental Investigation on the Role of Thermoacoustics on Soot Formation

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Abstract : Combustion in itself is a complex phenomenon that involves the interaction and interplay of multiple phenomena, the combined effect of which gives rise to the common flame that we see and use in our daily life applications from cooking to propelling our vehicles to space. The most important thing that goes unnoticed about these flames is the effect of the various phenomena from its surrounding environment that affects its behavior and properties. These phenomena cause a variety of energy interactions that lead to various types of energy transformations which in turn affect the flame behavior. This paper focuses on experimentally investigating the effect of one such phenomenon, which is the acoustics or sound energy on diffusion flames. The subject in itself is extensively studied upon as thermo-acoustics globally, whereas the current work focuses on studying its effect on soot formation on diffusion flames. The said effect is studied in this research work by the use of a butane as fuel, fitted with a nozzle that houses 3 arrays consisting of 4 holes each that are placed equidistant to each other and the resulting flame impinged with sound from two independent and similar sound sources that are placed equidistant from the centre of the flame. The entire process is systematically video graphed using a 60 fps regular CCD and analysed for variation in flame heights and flickering frequencies where the fuel mass flow rate is maintained constant and the configuration of entrainment holes and frequency of sound are varied, whilst maintaining constant ambient atmospheric conditions. The current work establishes significant outcomes on the effect of acoustics on soot formation; it is noteworthy that soot formation is the main cause of pollution and a major cause of inefficiency of current propulsion systems. This work is one of its kinds, and its outcomes are widely applicable to commercial and domestic appliances that utilize combustion for energy generation or propulsion and help us understand them better, so that we can increase their efficiency and decrease pollution.

Keywords : thermoacoustics, entrainment, propulsion system, efficiency, pollution
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