Design of Optical Diagnostic System for Wave Rotor Constant Volume Combustor

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The recent energy price hike brings the urge to produce a more efficient power generation engines, which could result in lower fuel consumption, higher efficiency and less pollutants. Such a new approach is being developed at IUPUI with the participation of global engine maker Rolls Royce, utilizing an alternate thermodynamic cycle (Humphrey cycle) and a novel pulsed combustor for gas turbine engines, called a Wave Rotor Combustor (WRC). The proposed wave rotor ignition test rig consists of two combustion chambers (a rotating pre-chamber and a stationary main chamber), electrical and ignition systems and data acquisition system. Experiments and numerical studies have been conducted to study the ignition and flame propagation process using different hydrocarbon fuels (methane, ethylene and propane). Currently, hydrogen cannot be used for experiments because it does not produce soot; consequently, the flame propagation process cannot be visualized with the images captured using high speed camera. Therefore, the objective of the present research is to design an optical system to visualize the flame propagation process in a WRC for all fuels including hydrogen. Among various optical techniques available for flow visualization, Schlieren photography is commonly used for flows with sharp density gradients. Based on the configuration there are different types of Schlieren imaging system such as Z-type, parallel beam system and single mirror system. From our present research we have identified that Z-type Schlieren system meets all our requirements; suitable for present study, low cost, easy to set-up. All the components required to design the Z-type Schlieren system have been finalized, ordered and all the components have been received. Initially, Schlieren system is being tested using a simple combustion light source such as candle flame. Later, experiments will be conducted using different fuels to visualize the flame propagation process inside the wave rotor combustor.

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