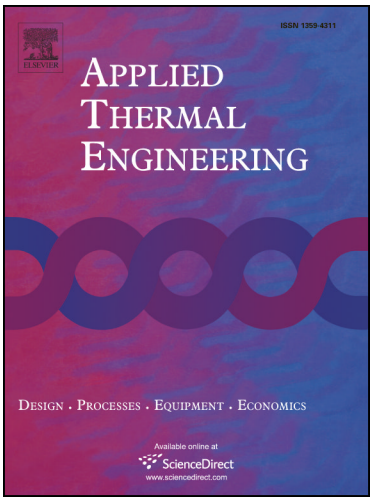

Research Paper

Experiment on the ignition performances of a free-piston diesel engine alternator

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Experiment on the ignition performances of a free-piston diesel engine alternator

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Abstract: The free-piston engine alternator (FPEA) is an unconventional engine. The initialization of the new engine differs from the conventional engine due to the feature that it eliminates the crankshaft and flywheel system. This study performed an experiment to analyze the ignition characteristics of a compression ignited diesel FPEA. Meanwhile, the effects of injection position and starting force on the ignition were also investigated. The experimental result shows that the larger starting force does not absolutely bring about higher ignition efficiency for the initialization of FPEA, although it brings in a greater possibility for the engine to gain a higher compression ratio from its resonant reciprocation. The large, but inappropriate starting force may lead to a serious incomplete combustion for the ignition, and the level of combustion completion of ignition is influenced by the injection triggering advance position (ITAP). The experiment suggests that properly enlarging the ITAP can enhance the combustion efficiency of the ignition and is beneficial to enlarge the compression ratio of opposite cylinder, but an excessive ITAP may advance the injection and ignition cycle and further induce a misfire for the FPEA.

Keywords: free-piston diesel engine, experiment, ignition, combustion efficiency, injection position

1. Introduction

Low efficiency and high emission have become the two greatest bottlenecks for the conventional reciprocating combustion engine. Researchers are not only exploring advanced technique to break through the bottlenecks of conventional engine, but also working to develop new engine device with high efficiency and clean emission [1-3]. Recently, an unconventional linear electric engine device called free-piston engine alternator (FPEA) was proposed as a potential alternative to conventional reciprocating engine [4-5]. The FPEA is an integration of a free piston combustion engine and a linear alternator [6-7]. Unlike the conventional engine, it removes conventional crankshaft system and is featured with a free, controllable piston motion [8-9]. This feature brings about extensive conveniences and advantages for the FPEA, such as variable engine compression ratio, low mechanical loss, multi-fuel adjustability, and flexible combustion mode transformation [10-11]. However, eliminating the crankshaft system gets these advantages and attaches some new technical difficulties for the FPEA. The FPEA motion is determined by the instantaneous forces acting on the mover, and it is therefore influenced by the combustion [12-13]. The piston motion trajectory may be varied for different operating conditions [14-15]. Variations between consecutive cycles due to cycle-to-cycle variations in the combustion are also possible [16-17]. The FPEA requires more precious and complicated control system to overcome the instability of piston motion [18-19]. Moreover, a well gas exchange of FPEA is strongly required to obtain high scavenging efficiency and minimize the unburned fuel loss for the mixture preparation, since the FPEA generally adopts two-stroke mode

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