Performance and emission evaluations of a prototype stepped-piston engine using carburetor and direct fuel injection systems

Abstract

Two-stroke engines have been used for sometimes in automotive and stationary applications since early 20th century. The advantages of two-stroke engines are obvious, i.e., lighter, simpler and less expensive to manufacture. Technically, two-stroke engines have the potential to pack almost twice the power into the same space because there are twice as many power strokes per revolution. The combination of lightweight and twice the power gives two-stroke engines a great power-to-weight ratio compared to many four stroke engine designs. However due to the short-circuiting process of the fuel before combustion, this has resulted in deterioration in overall performances especially poor combustion efficiency and high white smoke emission problem. Coupled with the improvement in the four-stroke engine technology, the former has overcome the latter in being the choice for mobile platform applications. Due to high fuel cost and the need to explore the use of other fuel sources, notably gaseous fuels, a number of enthusiasts and engine developers have revisited the two-stroke engine design. Fuels such as hydrogen and methane are said to be ideal for use with the incorporation of the some new features (Goldsborough and Blaringan, 2003).

An engine design and development program was initiated at Universiti Teknologi Malaysia (UTM) in year 2003 to develop local R&D capabilities in small power-train engineering. The exercise evolved around the development of an air-cooled single cylinder of stepped-piston engine concept. The term “stepped piston” refers to the conventional piston having compounded with a larger diameter section at the rear section of its geometry. The changes to the original design were made as the research group feels that there are rooms for improvements. In addition to this, the modifications will infuse other innovative scope of work from design to product testing activities (Hooper, 1985).This program, eventually leads to the incorporation of features, is expected to enhance performance of the prototype and subsequently exhaust emission. This is in anticipation of producing a working prototype for multiple applications namely stationary and automotive. The gasoline stepped-piston engine is a relatively new design concept for small mobile power plants. It is an engine, operating on a two-stroke cycle but is infused with four-stroke engine features. It has a build-in supercharger mechanism (by virtue of the extended

flange) that improves the scavenging process thus improve combustion efficiency. Due to these operating characteristics, the engine has all the attributes of a low emission, high-efficiency power plant that eliminates many of the major weaknesses associated with the Otto four-stroke engine and with modern two-stroke engines.