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A review on fuel economy test procedure for automobiles: Implementation possibilities in Malaysia and lessons for other countries

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ABSTRACT

Automobiles are considered as the main energy consumer in the transportation sector. According to the National Energy Balance, its accounted for about 36% of the total energy consumption in Malaysia. In order to reduce energy consumption in this sector, this country must consider setting fuel economy standards for motor vehicles sometime in near future. The first step toward developing fuel economy standards is to create a precise test and rating procedure for the automobiles. The test procedure is the technical foundation for all related programs namely; fuel economy standards, fuel economy labels and incentive programs. The test conditions should represent the driving situations and environment of the country. This paper is attempts to present a critical review on fuel economy testing procedure around the world and to propose a process for selecting a fuel economy test procedure for automobiles based on the conditions and requirements of the country. The internationally recognize test procedure adopted by several countries is also presented in this paper. Even though the paper only discusses the test procedure for automobiles, the methods can be directly applied for other types of vehicles and in other countries without major modifications.

Contents

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1. Introduction

In the past decade the global warming and air pollution facing by the world today are reached to a critical level. Therefore, in the past few years there has been a growing concern about energy use and its adverse impact on the environment all over the world [1–5]. The most promising strategy to tackle this problem is to implement renewable energy and energy efficiency policies that are already been used in many developed countries around the world. Some of the successful programs on renewable energy implementation are presented in Refs. [6–30], some of the successful programs on energy efficiency are also discussed in Refs. [26–48]. One of the most successful programs is by implementing the fuel economy standard and labeling [49–51]. In many countries, cars are tested for fuel economy through standard procedures before being authorized for sale [52–57]. The test simulates a range of driving conditions at highway speeds and at speeds more typical of urban driving. All tests are simulated on-road fuel consumption of the vehicles. The tests reflect the value of fuel economy of the car based on the driving conditions. Unfortunately, normally in the developing countries, vehicles are not tested for fuel economy, in these countries governments are one of the best authorities who can introduce that kind of tests because the program is quite sensitive and can significantly affect the automotive market. However, in the absence of national test procedures, consumer organizations can act as an authority to develop test procedures, conduct the testing and publishing results in the interests of their members [126].

Generally, the fuel economy testing for a new automobile is differed from country to country and from region to region. This is due to the extent that the typical driving condition changes by country and region in a number of respects that will affect fuel consumption. This includes prevailing urban versus extra highway driving patterns, ambient temperatures that determine the use of air conditioners or heater. At the same time, there is dissatisfaction with current test procedures everywhere; real fuel consumption on the real environment tends to be higher than the laboratory tests used to certify new vehicles. The discrepancy arises particularly in stop-go, urban driving conditions [126]. Some of the works related to the vehicle test procedure are discussed by Refs. [58–71].

2. Automobile energy balance

In the internal combustion engine, most of the energy obtained from the fuel is released as a waste to the environment. The chemical energy conversion is used to turn the wheels to provide acceleration, to overcome aerodynamic drag and rolling resistance, lastly only 12.6% of the total energy converted is used as useful work and the rest is lost to the environment. Therefore, there is a significant potential to improve fuel economy using advanced technologies. The energy balance for an automobile is presented in Fig. 1 [72].

Even the latest internal combustion engines convert only one-third of the potential chemical energy of the fuel into useful mechanical work. The rest of the energy is lost as waste heat, the friction of moving engine parts and pumping air into and out of the engine. All of these steps at which energy is wasted, provides new opportunities for advanced technologies to improve the efficiency of automobile. As a result, emerging of new technologies is observed in almost each year and more advanced technologies in the research stage become available in the next 10–15 years. A more complete discussion of these technical issues can be found in Refs. [73–96].

3. Fuel economy test procedure

The world forum for harmonization of vehicle regulations of the United Nation economic commission for Europe has brought governments and automobile manufacturers together to work on a new harmonized test procedure to be adopted. The result is expected to increased focus on urban driving conditions, at least in regions that have less emphasis on these conditions in current tests. However, it is expected that it may take many years to come with an agreement. In the meantime, there might be merit in establishing a world standard emission test as an additional and complementary standard test to provide purchasers with information on fuel economy or fuel consumption. A global fuel economy test procedure, could include test variants that cover different types of driving conditions, allowing countries to use a weighted average of the variants to best reflect their own conditions. Europe, Japan, and the United States are the countries that have developed their own unique test procedures to determine fuel economy and greenhouse gas (GHG) emissions for new motor vehicles [126]. Some of the test procedure in used in other countries can be found in Refs. [97–99].

Several essential steps should be taken to establish fuel economy standards and labels; the first step is to establish a precise test procedure. A test procedure is the foundation for fuel economy standards, fuel economy labels and other related programs. It provides the manufactures, regulatory authorities and consumers a method of consistently evaluating fuel use across different models. The second step is to set up fuel economy standards based on the vehicle fuel economy test data. Nowadays, many vehicles have been tested with at least one of the test procedures when they want to be sold in the market. The data proved during the test can be used to accelerate setting the new test standards. And the third step is to develop uniform fuel economy labels. Although, labels are very informative for the consumers, but they are not absolutely necessary for standards. The energy labels, can contribute to further potential savings of the standards. The last step is to develop some incentive programs as an option for standards and labels. The