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DEVELOPMENT OF DRIVER FUEL ECONOMY INDEX FOR REAL ROAD FUEL ECONOMY

Taehun Ha[1)], Seonwoo Choi[1)], Yoonwoo Lee[2)] and Hoimyung Choi[3)*]

[1)] Gachon Institute of Future Automotive Propulsion Technology, Gachon University, Gyeonggi 13120, Korea
[2)]Vehicle Calibration Team, Tenergy, 145 Gwanggyo-ro, Yeongtong-gu, Suwon-si, Gyeonggi 16229, Korea
[3)]Department of Mechanical Engineering, Gachon University, Gyeonggi 13120, Korea

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ABSTRACT–Although a 5-cycle testing was adopted to address the gap between the reported fuel economy from certification tests and fuel economy during real-world driving, the gap still remains and is difficult to be resolved without the consideration of the fuel consumption influencing parameters such as driver's behavior, driving pattern and road condition. In this study, two types of driver fuel economy indices, the MAW (Moving Average Window) Power Ratio Index and the Constant Driving Index are newly defined to invent the index which can reflect the real-road conditions and simulate the real-world fuel economy. Both indices are defined as the ratio of actual driving to ideal (constant speed) driving in common but the former is based on the engine output and the latter is based on the work. Two types of indices are verified with 5-cycle testing results on chassis dynamometer. According to the verification, the MAW Power Ratio Index with window size of 60 seconds shows the highest correlation with the certified fuel economy and is the reasonable starting point of index for reflecting the real-road conditions.

KEY WORDS : Fuel economy, Fuel economy index, 5-cycle testing, Real road driving, Moving average window, Driver fuel economy index, MAW power ratio index, Constant driving index

1. INTRODUCTION

At the climate change conference in Paris in December 2015, an agreement was reached which contains goals and mechanisms for responding to climate change and binding obligations for all Parties. The Paris Agreement addresses the period from 2020 onwards. However, the Conference of the Parties agreed on specific activities for the period before 2020, including the promotion of and an exchange on mitigation and adaptation actions.

In this state, greenhouse gas (GHG) emission and fuel consumption regulations of automobile are also strengthened worldwide (Jeon *et al*., 2012). The fuel efficiency of an automobile is defined as a ratio of running distance to fuel consumption (Choi *et al*., 2011) and it can be an indicator for purchasing and maintenance costs of the vehicle to the drivers and technology development and energy management to the manufacturers (Rho and Shin, 2012). Although Corporate Average Fuel Economy (CAFE) standards had been implemented to provide the fuel economy objectively, the complaint that there was a gap between the reported fuel economy from certification tests and fuel economy during real-world driving was continuously raised. The fuel economy during real-world driving means the fuel economy recognized as a real value on the road throughout the driving by consumers. In result, a new measurement method of fuel economy called a 5-cycle fuel economy testing was introduced in 2012 to address the gap. The standard city test and highway test (2-cycle) are supplemented with three additional test cycles that account for the cold temperature operation, the air conditioner use, and the driving at higher speeds with more rapid acceleration and braking. The 5-cycle testing was estimated that the fuel economy was measured about 20 % lower than the previous fuel economy test method (Lim *et al*., 2017; Rho and Shin, 2012).

However, as a result of a survey on the fuel economy of consumers purchasing a new car for one year in 2013, the fuel economy during real-world driving was still lower than the fuel economy from certification tests 85.7 % in the city and 88.8 % in the highway (Auto Insight, 2015). Despite the adaption of the 5-cycle fuel economy testing, there is still a gap so additional solution is required.

In fact, the certified fuel economy cannot always accurately reflect the real-world fuel economy because there are a lot of factors that affect the fuel consumption in real-road conditions. Basically, the vehicle weight, vehicle shape, engine size, fuel type, transmission, after-treatment devices, fuel supply method and turbocharging system affect the fuel economy and those factors are already reflected to the certification (Ang *et al*., 1991). However, the driving conditions such as average vehicle speed,

**Corresponding author.* e-mail: hoimyung@gachon.ac.kr