International Journal of Automotive Technology, Vol. 21, No. 1, pp. 123−135 (2020)
DOI 10.1007/s12239−020−0013−z

pISSN 1229−9138/ eISSN 1976−3832

STATISTICAL ANALYSIS OF THE IMPACT OF VEHICLE RUNNING-IN DISTANCE ON MECHANICAL RESISTANCE

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(Received 18 March 2019; Revised 3 May 2019; Accepted 7 May 2019)

ABSTRACT−Certified testing of motor vehicle driving resistance, fuel economy and emissions requires that the vehicle has reached the target distance specified for each country through running-in. In general, motor vehicles experience different tire wear and internal resistance profiles from their moving parts, including the brake, hub bearing, drive shaft and transmission, depending on how they have performed running-in over what range. This means that such differences can result in a discrepancy in the level of mechanical resistance that consists of tire rolling resistance and internal resistance. There is thus a potential impact on the fuel economy and emissions as tested by the chassis dynamometer. In this study, the nomenclatures define where the running-in testing takes place ("Location"), how the testing is performed ("Mode") and over which distance the testing takes place ("Distance") as the factors having the major impact on the mechanical resistance of a motor vehicle. Then the mechanical resistance was measured under different running-in distances using a chassis dynamometer and the determination was made on how the resistance decrease over the range to understand statistically how Location and Mode affect the reduction in mechanical resistance under different Distances. This study was also evaluated on which running-in test mode is the best for fuel economy and emissions certification through total cost analysis over the 6,500 km running-in distance. In addition, the process to identify the impact of vehicle running-in test conditions on the reduction in the mechanical resistance of the vehicle was suggested.

KEY WORDS : Running-in distance, Mechanical resistance, Driving mode, Chassis dynamometer, Regression model

1. INTRODUCTION

Road transportation constitutes approximately one fifth of the total CO_2 emissions in Europe, while from passenger cars represent about 75 percent of major greenhouse gas emission (EEA, 2015a, 2018; European Comission, 2015). Emissions from motor vehicles have a negative impact on the global environment and human health: they contribute to global warming and worsen air quality. In response, governments all over the world are tightening their regulations on CO_2 and emissions (Heywood and Welling, 2009; Myung *et al*., 2014; Platt *et al*., 2017). To meet the stricter regulations on fuel economy and CO_2, an annual improvement of 3.7 percent is needed for fuel economy by 2020 (Dings, 2015). Automakers have invested heavily in developing new motor vehicles that can offer better fuel economy and lower CO_2 emissions. Indeed, average vehicle fuel economy has improved over the past 5 years (Kadijk *et al*., 2012; Kasab *et al*., 2012). In fact, a report issued by the European Environmental Agency (EEA) in 2015 shows that average CO_2 emissions for all the automakers in Europe combined is 123.4 gCO_2/km in 2014, which is already lower than the target 130 gCO_2/km. It estimates the figure for 2015 at 120.7 gCO_2/km (EEA, 2015b, 2016a, 2016b). Despite the remarkable improvement in fuel economy made by automakers, many critics point to a discrepancy between the lab certified value and actual fuel economy or CO_2 emissions (Mock and German, 2015). Reports issued in the mid to late 2000s estimate the difference at around 12 to 20 percent (Transport, 2005; Hausberger and Zallinger, 2011) while those issued more recently estimate it at as much as 30 to 40 percent (Dings, 2013; Tietge *et al*., 2015). More evidence is surfacing that the recent improvement in the fuel economy is associated more with testing driven optimization and practices pertaining to the testing, that is, flexibility factors than with implementation of fuel-saving technologies (Mellios *et al*., 2011; Weiss *et al*., 2011; Fontaras and Dilara, 2012; Norbert, 2012; Ligterink *et al*., 2013; Mock *et al*., 2014; Tietge *et al*., 2015; Duarte *et al*., 2016; Zacharof *et al*., 2016). Flexibility factors associated with the coastdown testing include vehicle running-in distance, wheel and tire specifications, tire pressure, surface condition, test mass, brake drag, warm-up time and

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