Plenary 4

Effect of Inflation Pressure on Tire Rolling Resistance and Vehicle Fuel Economy

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Walter H. Waddell is a Senior Research Associate in Global Polymers Technology at ExxonMobil Chemical Company. He has a Ph.D. in Chemistry, University of Houston and a B.S. in Chemistry, University of Illinois at Chicago. He was a Research Associate at Columbia University where he received a Research Fellow Award from the U.S. National Institutes of Health, an Associate Professor of Chemistry at Carnegie-Mellon University, Section Head in Research at The Goodyear Tire & Rubber Co., and Senior Scientist, Silica Technology at PPG Industries. Walter has received numerous awards including the Distinguished Corporate Inventor; the Sparks-Thomas Award and the Melvin Mooney Distinguished Technology Award from the Rubber Division, American Chemical Society; International Rubber Conference Medal; and Award of Appreciation from the ASTM F09 Committee on Tires. He has published over 150 papers, presented over 150 seminars globally, and is an inventor with 40 United States patents.

1. Abstract

Inflation pressure loss rates (IPLR) were measured for >300 passenger car tires manufactured worldwide. Rolling resistance forces were measured and coefficients (RRC) calculated for 83 models. RRC was also measured upon decreasing inflation pressure in order to calculate the change in vehicle fuel economy with pressure loss. Current and projected data from the Exxon Mobil 2014 Energy Outlook is used for total light vehicles worldwide, and in selected countries in Asia Pacific. Using the average distances that vehicles are driven yearly and the average number of liters consumed to drive 100 kilometers, the total fuel consumed each year can be calculated. The potential fuel saved can then be calculated as a function of air loss using tire IPLR and tire reinflation at 3-month intervals. Corresponding savings in CO₂ emissions are estimated.

2. Introduction

Common Position (EC) no. 18/2009 was adopted by the European Parliament in November 2009, labeling of all tires with respect to fuel efficiency. It became mandatory on 1 November 2012¹. ISO 28580 was developed as the rolling resistance test (RRC, kg/t). Japan² and Korea have established mandatory tire labeling, and Brazil and China³ plan to adopt regulations similar to that of the EU. The U.S. has not yet adopted mandatory labels. Inflation pressure is critical for optimum tire and vehicle performance. It affects tire traction, handling, tread wear, durability and rolling resistance, and thus vehicle performance.

3. Results and Discussion

The ISO 28580 RRC of 83 tires manufactured worldwide averages 9.9 kg/t. Figure 1 shows RRC grouped into three regions: Americas, Europe, and Asia Pacific. Figure 2 shows their EU Energy Efficiency Classes¹. In 2015, the total light vehicle population worldwide was approximately 956 million, corresponding to about 154 vehicles/1000 people, but varying greatly by region: North America, South America, Europe, Africa, Middle East, and Asia Pacific. The average light vehicle was driven about 14,100 km/year, and averaged 9.1 L/100-km. For selected Asia Pacific countries, data also varies widely, see Figure 3. Japan, China, Taiwan, South Korea, and India have the highest number of vehicles, see Figure 4.

Fig. 1 RRC by region of tires manufactured worldwide

Fig. 2 Distribution of RRC into EU Classes

Fig. 3 Light vehicles in Asia Pacific countries

Fig. 4 Light vehicles in selected countries

Tires lose air based on the innerliner quality determining IPLR, see Figure 5. This affects RRC and the EU Energy Efficiency Class, see Figure 6. Tire E is a Class C at the ISO 28580 test pressure = 210 kPa, but at ~190 kPa becomes a Class E. If not reinflated, it could potentially be an EU Energy Efficiency Class F.

Fig. 5 Air loss based on IPLR at a 3-month reinflation

Fig. 6 Change in RRC with tire pressure

The increase in tire RRC then depends on both IPLR and the time period in between reinflations, see Figure 7. If the tire is not reinflated, the yellow low tire pressure indicator (TPMS) could be activated in the vehicle. Thus, potential fuel savings worldwide (see Figure 8) and in selected Asia Pacific countries (see Figure 9) can be calculated, with corresponding CO₂ emission potentially saved estimated, see Figure 10.

Fig. 7 RRC increase based on IPLR and reinflation

Potential Fuel Savings if IPLR <2.5%, billion liters

Fig. 8 Potential fuel savings if IPLR = 2.5%/month

Potential Fuel Savings if IPLR=2.5% maximum, million liters

Fig. 9 Potential fuel savings if IPLR = 2.5%/month

Estimated CO₂ Emissions Saved, MMT

Fig. 10 Potential CO₂ saved if IPLR = 2.5%/month

4. Summary

Manufacturing tires to IPLR<2.5%/month maximum and reinflating at 3-month time intervals, could save ~9.4 billion liters of fuel worldwide in 2015. This corresponds to ~21.7 MMT of CO₂ emissions. For all countries in Asia Pacific, ~3.0 billion liters of fuel and 6.8 MMT of CO₂ could have potentially been saved.

5. References

[1] Official Journal of the European Union, C 298 E, Vol 52, 8 December 2009

[2] “Guideline for tyre labeling to promote the use of fuel efficient tyres (labeling system)”; <http://www.jatma.or.jp/english/labeling/pdf/labelingsystemE.pdf>

[3] <http://news.cria.org.cnhttps://www.linkedin.com/pulse/china-introduces-tire-labelling-where-opportunities-david-shaw/2/19429.html>

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