UMTRI-2014-1 JANUARY 2014

Fuel and Money Saved Using Tires with Low Rolling Resistance

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UMTRI
University of Michigan
Transportation Research Institute

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Report No. UMTRI-2014-1
January 2014

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTRI-2014-1		

4. Title and Subtitle	5. Report Date
Fuel and Money Saved Using Tires with Low Rolling Resistance	January 2014
	6. Performing Organization Code 383818
7. Author(s) Michael Sivak	8. Performing Organization Report No. UMTRI-2014-1
9. Performing Organization Name and Address The University of Michigan Transportation Research Institute 2901 Baxter Road Ann Arbor, Michigan 48109-2150 U.S.A.	10. Work Unit no. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address The University of Michigan Sustainable Worldwide Transportation http://www.umich.edu/~umtriswt	13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This study was designed to examine how using tires that are at the current extremes of rolling resistance affects fuel consumption by light-duty vehicles in the U.S. The analysis was based on rolling-resistance measurements for 63 tire models that were obtained under uniform test conditions by Consumers Union (the publisher of *Consumer Reports*). These tires represent a cross-section of the currently available T-, H-, and V-speed-rated tires for light-duty vehicles on the U.S. market. All 63 tire models were evaluated at the same load (1,033.9 lbs) and at the same inflation pressure (37.9 psi). The analysis was performed for each speed-rated subset of tires and for the combined set of all tires. The data are presented for the median, minimum, and maximum of the respective distributions of rolling resistance, and for four percentile levels (10^{th}, 25^{th}, 75^{th}, and 90^{th}).

Rolling resistance (RRf) for the combined set of all examined tires ranged from 6.89 lbs to 12.50 lbs, with a median of 10.28 lbs. Given that the current average on-road fuel economy of light-duty vehicles is 21.4 mpg (assumed to be obtained at RRf of 10.28 lbs—the median of our tire sample), the obtained rolling resistance extremes translate into a maximum fuel economy of 22.4 mpg (at RRf = 6.89 lbs) and a minimum fuel economy of 20.7 mpg (at RRf = 12.50 lbs). Consequently, the obtained rolling resistance extremes yield a minimum and maximum annual fuel consumption of 505 gallons and 547 gallons, respectively. At the average 2013 price of regular gasoline, the obtained fuel-consumption results in a \$147 difference in the annual cost of gasoline per light-duty vehicle.

17. Key Words	18. Distribution Statement
Tires, rolling resistance, fuel savings, operational cost savings	Unlimited

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
None	None	10	

Contents

Acknowledgments

Appreciation is extended to Consumers Union for providing the raw rolling-resistance data for the tires used in this analysis, and to Dr. Marion Pottinger (M'gineering, LLC) for advice and comments on a draft of the report. However, the author is solely responsible for the content of the report.

Introduction

Rolling resistance of tires has a direct effect on vehicle fuel economy. A recent comprehensive review (TRB, 2006) concluded that for each 10% change in rolling resistance there is a 1% to 2% change in fuel economy of light-duty vehicles.

The present study was designed to examine how using tires that are at the current extremes of rolling resistance affects fuel consumption of light-duty vehicles. The analysis was based on rolling-resistance measurements of a large set of tires that were obtained under uniform test conditions by Consumers Union (the publisher of *Consumer Reports*). These tires represent a cross-section of the currently available T-, H-, and V-speed-rated tires on the U.S. market.

Method

Tire sample

Consumers Union provided us with the rolling-resistance values for 63 tire models that were tested at the same load (1,033.9 lbs) and at the same inflation pressure (37.9 psi). In this set, 20 tires were T-speed rated (118 mph), 20 tires were H-speed rated (130 mph), and 23 tires were V-speed rated (149 mph). All tires were size (P)215/60R16. The analysis was performed for each speed-rated subset of tires and for the combined set of all tires. (The values used in the analysis were the averages of three tires per model.)

Approach

The analysis involved the following comparisons:

• tires at various percentiles of the distribution of rolling resistance versus a tire at the median (the 50^{th} percentile) of rolling resistance

• a tire with the minimum rolling resistance versus a tire with the maximum rolling resistance

Of interest were the expected changes in fuel consumption and the consequent changes in the cost of fuel for operating a light-duty vehicle.

Results

Rolling resistance

Table 1 describes the rolling resistance of the tires in the sample. The median rolling-resistance values of tires in each speed-rated group were similar (10.25 lbs, 10.39 lbs, and 10.28 lbs, respectively). However, the maxima and minima of the H- and V-rated tires were higher than those of the T-rated tires (12.47 lbs and 12.50 lbs vs. 11.98 lbs, and 7.71 lbs and 7.96 lbs vs. 6.89 lbs, respectively).

Table 1
Distributions of tire rolling resistance.

Measure	Rolling resistance, RRf (lbs)			
	T speed	H speed	V speed	All
Minimum	6.89	7.71	7.96	6.89
10th percentile	8.36	8.12	8.99	8.52
25th percentile	9.48	8.94	9.65	9.47
50th percentile (median)	10.25	10.39	10.28	10.28
75th percentile	11.01	11.16	11.09	11.07
90th percentile	11.32	11.90	11.84	11.43
Maximum	11.98	12.47	12.50	12.50

Change in vehicle fuel economy

Given the TRB estimate that for each 10% change in tire rolling resistance there is a 1% to 2% change in fuel economy (TRB, 2006), the calculations in this study assumed a 1.5% change in vehicle fuel economy for each 10% change in rolling resistance. Table 2 shows the percentage change in fuel economy relative to the tire with the median rolling resistance. For the combined set of all tires, vehicle fuel economy for tires with the minimum rolling resistance is about 4.9% better than for tires with the median rolling resistance; for tires with the maximum rolling resistance, vehicle fuel economy is 3.2% worse.

Table 2
Effects of tire rolling resistance on vehicle fuel economy.

Rolling resistance	Average change in vehicle fuel economy relative to tires with the median rolling resistance (%)			
	T speed	H speed	V speed	All
Minimum	+4.9	+3.9	+3.4	+4.9
10th percentile	+2.8	+3.3	+1.9	+2.6
25th percentile	+1.1	+2.1	+0.9	+1.2
50th percentile (median)	0.0	0.0	0.0	0.0
75th percentile	-1.1	-1.1	-1.2	-1.2
90th percentile	-1.6	-2.2	-2.3	-1.7
Maximum	-2.5	-3.0	-3.2	-3.2

Vehicle fuel economy

The latest available data for light-duty vehicles (for 2011) indicate that the average annual on-road fuel economy is 21.4 mpg (Sivak, 2013a; 2013b).

Table 3 presents the effects of tire rolling resistance on the fuel economy of light-duty vehicles currently in use. These calculations are based on the information in Table 2 and on the assumption that the mean and median fuel economy are the same (21.4 mpg). Furthermore, because the median rolling resistances of the T-speed-, H-speed-, and V-speed-rated tires each differed from the median of the combined set of tires by 1% or less (see Table 1), the median fuel economy is effectively the same for all four distributions (21.4 mpg).[1] For the combined set of all tires, the average vehicle fuel economy for tires with the minimum rolling resistance is 22.4 mpg, while for tires with the maximum rolling resistance it is 20.7 mpg.

Table 3
Vehicle fuel economy as a function of tire rolling resistance.

Rolling resistance	Average on-road vehicle fuel economy (mpg)			
	T speed	H speed	V speed	All
Minimum	22.4	22.2	22.1	22.4
10th percentile	22.0	22.1	21.8	21.9
25th percentile	21.6	21.8	21.6	21.6
50th percentile (median)	21.4	21.4	21.4	21.4
75th percentile	21.1	21.1	21.1	21.1
90th percentile	21.0	20.9	20.9	21.0
Maximum	20.8	20.7	20.7	20.7

[1] Given that a 10% change in rolling resistance results in a 1.5% change in vehicle fuel economy, a 1% change in rolling resistance results in only a 0.15% change in vehicle fuel economy—too small a change to notice when fuel economy is expressed in miles per gallon with a precision of one decimal point.

Fuel consumption

Average annual fuel consumption per light-duty vehicle as a function of tire rolling resistance is shown in Table 4. The information in Table 4 is based on vehicle fuel economy in Table 3 and the current average distance driven per light-duty vehicle (11,318 miles; Sivak, 2013a).

For the combined set of all tires, the difference between the tires at the two extremes of rolling resistance is 42 gallons per year. This difference corresponds to an 8.3% increase in fuel consumption for tires with the maximum rolling resistance compared to tires with the minimum rolling resistance. The analogous differences for T-speed-, H-speed-, and V-speed-rated tires are 39 gallons, 37 gallons, and 35 gallons, respectively.

Table 4
Effects of tire rolling resistance on annual fuel consumption.

Rolling resistance	Average annual fuel consumption (gallons)			
	T speed	H speed	V speed	All
Minimum	505	510	512	505
10th percentile	514	512	519	517
25th percentile	524	519	524	524
50th percentile (median)	529	529	529	529
75th percentile	536	536	536	536
90th percentile	539	542	542	539
Maximum	544	547	547	547

Cost of fuel

Table 5 lists the average difference in the annual cost of gasoline consumed as a function of tire rolling resistance. The calculations in Table 5 used fuel consumption in Table 4 and the average price of regular gasoline in 2013 ($3.505; EIA, 2014).

For the combined set of all tires, the difference in the cost of fuel consumed using tires at the two extremes of rolling resistance is $147 per year. The analogous differences in the cost of fuel for T-speed-, H-speed-, and V-speed-rated tires are $137, $130, and $123, respectively.

Table 5
Effects of tire rolling resistance on annual cost of fuel consumed.

Rolling resistance	Average annual cost of gasoline for operating a vehicle relative to a vehicle with tires with the median rolling resistance ($)			
	T speed	H speed	V speed	All
Minimum	-84	-67	-60	-84
10th percentile	-53	-60	-35	-42
25th percentile	-18	-35	-18	-18
50th percentile (median)	0	0	0	0
75th percentile	25	25	25	25
90th percentile	35	46	46	35
Maximum	53	63	63	63

Discussion

Incremental fuel consumed and cost for using tires with high rolling resistance

For the combined set of all tires, the added fuel consumed with tires at the current maximum rolling resistance represents an 8.3% increase compared to the fuel consumed with tires at the current minimum rolling resistance. The same percentage increase applies to the difference in the cost of fuel consumed.

Variations within tire groups

The difference in fuel consumption between tires at the current maximum and minimum rolling resistance is greatest for T-speed-rated tires, followed by H-speed-rated tires, and V-speed-rated tires. However, this variation is relatively small. Specifically, the difference for T-speed-rated tires is only 11% greater than the difference for V-speed-rated tires. The same applies to the difference in the cost of fuel consumed.

Tires not considered

The study examined tires belonging to three tire groups (T-, H-, and V-speed-rated tires). Other tires (e.g., ultra-high-performance tires and winter tires) were not considered.

New tires versus worn tires

The calculations in this study apply to new tires. With lower tread depths, rolling resistance decreases, resulting in improved vehicle fuel economy. Reduction of the tread depth to 0% of the initial skid depth (completely worn out) compared with current new tire-tread depths reduces rolling resistance by about 20% to 26%, with the process essentially linear with tread-depth reduction (Martini, 1983; Schuring, 1980). However, before considering a designed reduction in tread depth, it would be necessary to carefully evaluate the effect on the average wet traction of tires in service and the effects on the number of tires to be manufactured and disposed of.

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