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BENEFITS OF USING TIRES WITH LOW ROLLING RESISTANCE

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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 49 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 49 tire models were size (P)215/60R16, and they were evaluated as specified in the SAE Recommended Practice J1269. The obtained rolling resistance values were then normalized to 1,033.9 lb and 37.9 psi—the same load and inflation pressure as in the previous study in this series. The analysis was performed for each speed-rated subset of tires and for the combined set of all tires. The data are presented for following locations in the distribution of rolling resistance: minimum, 25th percentile, 50th percentile (median), 75th percentile, and maximum.

Rolling resistance (RRf) for the combined set of all examined tires ranged from 8.1 lb to 12.1 lb, with a median of 9.9 lb. Given that the current average on-road fuel economy of light-duty vehicles is 21.6 mpg (assumed to be obtained at RRf of 9.9 lb—the median of our tire sample), the obtained rolling resistance extremes translate into a maximum fuel economy of 22.2 mpg (at RRf = 8.1 lb) and a minimum fuel economy of 20.9 mpg (at RRf = 12.1 lb). The obtained rolling resistance extremes yield a minimum and maximum annual fuel consumption of 511 gal and 543 gal, respectively. At the average 2015 price of regular gasoline, the obtained fuel-consumption extremes result in a $78 difference in the annual cost of gasoline per light-duty vehicle.

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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 update information from a study published in 2014 (Sivak, 2014) on 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 49 tire models. In this set of tires, 16 were T-speed rated (118 mph), 16 were H-speed rated (130 mph), and 17 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.)

The tires were evaluated as specified in the SAE Recommended Practice J1269 (SAE, 2006). The obtained rolling resistance values were then normalized to 1,033.9 lb and 37.9 psi—the same load and inflation pressure as in the previous study in this series (Sivak, 2014).

Approach

Of interest were the expected changes in fuel consumption and the consequent changes in the cost of fuel for operating a light-duty vehicle. The analysis considered tires that were at the following locations in the distribution of rolling resistance: minimum, 25th percentile, 50th percentile (median), 75th percentile, and maximum.

Results

Rolling resistance

Table 1 describes the rolling resistance of the tires in the sample. The median rolling-resistance value of all tires was 9.90 lb. There was a general tendency of H-speed-rated tires to have the lowest rolling resistance, followed by T-speed-rated tires, and V-speed-rated tires (with the respective medians of 9.70 lb, 9.85 lb, and 10.20 lb).

Table 1
Distributions of tire rolling resistance, by tire group.

Measure	Rolling resistance, RRf (lb)			
	T-speed rated	H-speed rated	V-speed rated	All
Minimum	8.70	8.10	9.00	8.10
25th percentile	9.30	9.15	9.50	9.30
50th percentile (median)	9.85	9.70	10.20	9.90
75th percentile	10.55	10.88	11.05	10.80
Maximum	11.70	11.60	12.10	12.10

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. The calculations used the latest available annual data for the average on-road fuel economy of light-duty vehicles, which was 21.6 mpg in 2013 (Sivak and Schoettle, 2015).

Table 2 presents the effects of tire rolling resistance on the fuel economy of light-duty vehicles currently in use. These calculations were based on the rolling resistance values in Table 1. The calculations assumed that the mean and median fuel economy for all tire groups combined are the same—21.6 mpg.

For the combined set of all tires, the average vehicle fuel economy for tires with the minimum rolling resistance is 22.2 mpg, while for tires with the maximum rolling resistance it is 20.9 mpg.

Table 2
Vehicle fuel economy as a function of tire rolling resistance, by tire group.

Rolling resistance	Average on-road vehicle fuel economy (mpg)			
	T-speed rated	H-speed rated	V-speed rated	All
Minimum	22.0	22.2	21.9	22.2
25th percentile	21.8	21.8	21.7	21.8
50th percentile (median)	21.6	21.7	21.5	21.6
75th percentile	21.4	21.3	21.2	21.3
Maximum	21.0	21.0	20.9	20.9

Change in vehicle fuel economy

Table 3 shows the percentage change in fuel economy relative to the tire with the median rolling resistance. The data in Table 3 are calculated from the fuel-economy values in Table 2.

For the combined set of all tires, vehicle fuel economy for tires with the minimum rolling resistance is about 2.8% better than for tires with the median rolling resistance; for tires with the maximum rolling resistance, vehicle fuel economy is about 3.2% worse.

Table 3
Effects of tire rolling resistance on vehicle fuel economy, by tire group.

Rolling resistance	Average change in vehicle fuel economy relative to tires with the median rolling resistance (%)			
	T-speed rated	H-speed rated	V-speed rated	All
Minimum	+1.9	+2.3	+1.9	+2.8
25th percentile	+0.9	+0.5	+0.9	+0.9
50th percentile (median)	0.0	0.0	0.0	0.0
75th percentile	-0.9	-1.8	-1.4	-1.4
Maximum	-2.8	-3.2	-2.8	-3.2

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 2 and the current average distance driven per light-duty vehicle (11,346 miles; Sivak, 2015).

For the combined set of all tires, the difference between the tires at the two extremes of rolling resistance is 32 gal per year. This difference corresponds to a 6.3% increase in fuel consumption for tires with the maximum rolling resistance compared to tires with the minimum rolling resistance. The analogous differences for T-, H-, and V-speed-rated tires are 24 gal (4.7%), 29 gal (5.7%), and 25 gal (4.8%), respectively.

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

Rolling resistance	Average annual fuel consumption (gal)			
	T-speed rated	H-speed rated	V-speed rated	All
Minimum	516	511	518	511
25th percentile	520	520	523	520
50th percentile (median)	525	523	528	525
75th percentile	530	533	535	533
Maximum	540	540	543	543

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 2015 ($2.43–the average of the 52 weekly averages; EIA, 2016).

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 $78 per year. The analogous differences in the cost of fuel for T-, H-, and V-speed-rated tires are $58, $70, and $60, respectively.

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

Rolling resistance	Average annual cost of gasoline for operating a vehicle relative to a vehicle with tires with the median rolling resistance ($)			
	T-speed rated	H-speed rated	V-speed rated	All
Minimum	-22	-29	-24	-34
25th percentile	-12	-7	-12	-12
50th percentile (median)	0	0	0	0
75th percentile	+12	+24	+17	+19
Maximum	+36	+41	+36	+44

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 a 6.3% increase over the amount of fuel consumed with tires at the current minimum rolling resistance. The same percentage increase applies to the difference in the cost of fuel consumed.

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 $78 per year, based on the average price of regular gasoline in 2015 ($2.43; EIA, 2015). In comparison, using the average price of gasoline in 2014 ($3.36; EIA, 2015) would yield a difference of $108 per year.

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.

Recent changes in rolling resistance of new tires

The rolling resistances of the tires used in the present analysis were measured in 2015. Below are the main trends for all tires combined in comparison with the tires measured in 2012 (Sivak, 2014). (Both studies measured the same tire groups: T-, H-, and V-speed-rated tires.)

- The maximum rolling resistance has improved (from 12.5 lb to 12.1 lb).
- The minimum rolling resistance has worsened (from 6.9 lb to 8.1 lb).
- As a consequence of the previous two trends, the difference between the maximum and the minimum rolling resistances has decreased (from 5.6 lb to 4.0 lb).
- The percentage increase in rolling resistance from the minimum to the maximum has decreased (from 81% to 49%).

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