Tire Care and Maintenance: Protecting the Environment, Your Investment and Your Safety

Introduction

Tire use has a significant impact on our environment, primarily through the generation of used tires and excess use of fuel. Improperly maintained tires wear faster, use more fuel and can become unsafe.

The largest Canadian tire maintenance issue and biggest contributor to the problem of tire wear is tire under inflation. In a recent study, 70 percent of vehicles surveyed had one or more tires improperly inflated by more than 10 percent, and 56 percent had one tire under inflated by more than 10 percent, including 23 percent that had one or more tires under inflated by more than 20 percent.[1]

Although it is normal for tires to wear out over time, you can take steps to prolong the life of your tires.

How to measure tire inflation and other important maintenance steps, such as wheel alignment and tire balancing, rotation, repair and storage, will be discussed.

Aggressive driving habits, high-speed driving, rough use, rough roads and other adverse conditions can also cause premature wear, waste fuel and create hazardous driving conditions.

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1. The Environmental Impact of Improperly Maintained Tires

Used Tires

Improper maintenance shortens the life of your tires. Replacing your tires more often means that more tires go to landfills or recycling centres, and more energy is then used to produce new tires or to recycle them. This has an impact on climate change, the environment and our health.

Canadians scrap approximately 28 million tires every year – approximately one tire for every Canadian. It is estimated that 41 percent are converted into "crumb," 14 percent are used for molded products, 21 percent are used in tire-derived fuel, and the remaining 24% are export sales. [2]

The energy and material used to manufacture four tires is equivalent to 26 litres of gasoline, so just a 10 percent improvement in tire life will deliver significant environmental benefits.[3] For example, it would mean 2.8 million fewer used tires, along with a reduction in the gasoline and other types of energy required to transport, dispose of or recycle them. The energy equivalent to 2.8 million tires, approximately 18 million litres of gasoline, means preventing 43 600 tonnes of carbon dioxide (CO_2) from entering the atmosphere.

Increased Fuel Consumption

Canada's 17.6 million light duty vehicles[4] consumed about **38.3** billion litres of fuel in 2000,[5] an average of 2060 litres each. Tire rolling resistance is one of the main factors affecting fuel consumption variations (good and bad) at urban driving speeds; and rolling resistance is most affected by tire inflation. Each 5 percent (typically 14 kPa or 2 psi) of under inflation translates into 1 percent of increased fuel consumption. For every additional litre of fuel consumed, 2.4 kg of CO_2, a major greenhouse gas contributing to climate change, is emitted into the atmosphere, not to mention the other exhaust emissions produced. Based on a weighted average of under-inflated tires, the overall annual cost to Canada's light duty vehicle population is almost 643 million additional litres of fuel consumed, or about $500 million (based on average pump fuel price of $0.79/L) and 1.54 additional megatonnes of CO_2 being emitted into the atmosphere.

2. The Effects of Tire Inflation on Fuel Consumption, Tread Wear and Safety

Effects of Under Inflation

Under inflation is a key safety factor. At low pressures, the tire sidewall has increased sidewall flexing that causes excessive heat build up. This weakens the tire and makes it prone to blowouts or other failures.

Your car will use more gas if your tires are under inflated, due to increased rolling resistance. The commonly accepted ratio in the automotive industry is that fuel consumption increases 1 percent for every 5 percent of under inflation[6]. (See Table 1.)

Tires that are under inflated have a reduced contact patch, as they ride just on the edges of the tread. This increases tire wear and reduces grip, adversely affecting handling and stopping distances. Prolonged under inflation develops a distinct wear pattern on the tread face. (See Figure 2, "Shoulder wear.")

Running one tire at 180 kPa (26 psi) instead of a recommended 220 kPa (32 psi) could reduce the life of that tire by 10 000 km and can increase fuel consumption by up to 3 percent.

In fact, tires rely on pressure to maintain the grip between the tire's bead (the edge of the tire) and the rim of the wheel. If the pressure is too low, the tire could separate from the rim under aggressive handling or accident avoidance.

Under-inflated tires may squeal when stopping or cornering even at moderate speeds, particularly on warm pavement.

Table 1. The Effects of Under Inflation on Tire Wear and Fuel Use[7]

Percentage of Under Inflation	Percentage Wear Increase	Fuel Use Increase
10%	5%	2%
20%	16%	4%
30%	33%	6%
40%	57%	8%
50%	78%	10%

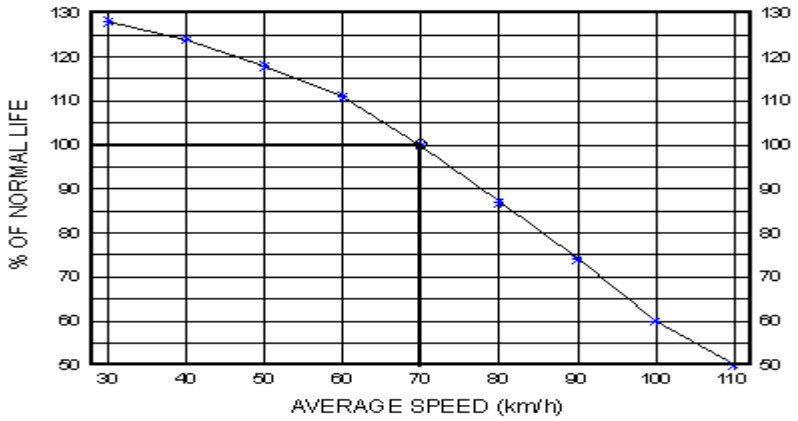
Effects of Over Inflation

A tire that is over inflated rides on just the centre portion of the tread. This causes premature wear in a distinctive pattern. (See Figure 2, "Centre wear.") The smaller contact patch means reduced grip on the road causing handling problems such as poor steering and stopping. Although higher tire pressure could mean lower rolling resistance and therefore lower fuel consumption, there is a limit – higher tire pressure also leads to a harsher ride, potential increased wear of steering and suspension components, and reduced tire life. Tires are designed to give their best operating performance on any specific vehicle at the inflation pressure shown on the vehicle information placard. This recommended pressure should be respected.

3. Other Factors Affecting Tread Wear

Driving fast will substantially reduce the life of your tires. As shown in Figure 1, tread life declines rapidly with increasing speed, wearing about 35 percent faster at 110 km/h than at 80 km/h.[8]

Figure 1. The Impact of Speed on Tire Wear



The type of road surface that you drive on most often will also affect the tire's life. Driving on rough, unpaved country roads can cut your tire's life in half.

Premature tire wear can also be caused by numerous mechanical conditions in your car. Worn or loose steering or suspension parts, misalignment and improper mounting and balancing can all contribute.

Drivers can prolong the life of their tires by reducing speed, driving less aggressively and performing regular maintenance. Some simple tire maintenance steps could substantially reduce the number of tires scrapped, with energy and environmental benefits accruing to all Canadians. Purchasing high durability tires will also help reduce the number of used tires generated each year.

4. Proper Tire Care and Maintenance

A. Monthly Inspection

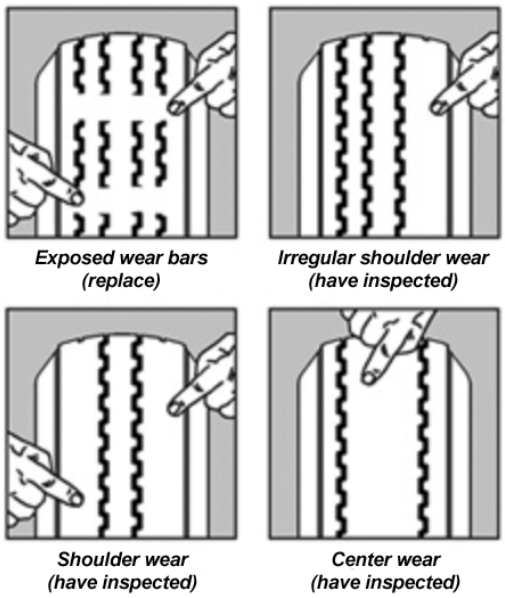
Regular tire care and maintenance is the key to the well being of your tires and your safety. Perform the following actions at least once a month:

- Measure your tires' pressure when they are cold, using a good quality tire gauge (you can't tell whether a tire is under inflated just by looking at it).
- Inspect the tread for signs of uneven wear.
- Inspect the tire for embedded stones, glass and other foreign objects that could work their way into the tire and cause a leak.

- Check the remaining tread depth – tires are manufactured with a "wear bar" that tells you when there is less than 1.6 mm (2/32 inch) of tread depth remaining – when you see this wear bar, the tire must be replaced.

Monitoring tire wear patterns (see Figure 2) can provide you with early indications of suspension and steering component problems, as well as show chronic tire inflation problems. Excessive wear on the inside or outside edges of the tire can indicate alignment problems. Excessive wear down the middle of the tire indicates chronic over inflation. Excessive wear on both outside shoulders indicates chronic under inflation. Feathering, a shredding of the rubber on the outside shoulder, can indicate an alignment problem; and cupping, a repeating bald spot around the tire's circumference, can indicate a wheel out of balance or a worn suspension. Embedded objects such as stones and glass can cause leaks.

Figure 2. Tread Wear Patterns



Most of the maintenance procedures that can be performed on tires tend to deliver more than one benefit. (See Table 2.) Here's how to save money, drive more comfortably and safely, and reduce environmental impacts.

Table 2. Benefits of Proper Tire Maintenance Practices

	Prolonged Tire Life	Fuel Savings	Better Handling	Safety	Driving Comfort
Inflation Check "cold" once per month	√	√	√	√	√
Alignment Check annually, or every 25 000 km	√	√	√	√	√
Balancing Every 20 000 km, or when vibrations develop	√	√	√	√	√
Rotation Every 10 000 km	√				√

Note: Service interval recommendations are the average. See your owner's manual for specific details.

B. Tire Inflation

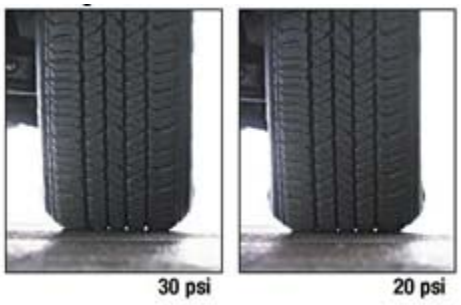
Measure your tires' inflation pressure at least once a month, or when the temperature changes abruptly.

Changes in ambient temperature cause changes in tire pressure, which is particularly important in Canada's climate where temperature swings of 15 to 20°C are not uncommon. Every 5°C change in temperature results in about a 7-kPa (1-psi) change in tire pressure, so a temperature drop of 15°C would result in approximately 10 percent (21 kPa or 3 psi) under inflation.[9] Additionally, tires are permeable and losses of up to 14 kPa (2 psi) per month are not uncommon – more in hot weather, as the pores in the tire material expand.[10]

Tire valves may become worn, and tire damage may result from rough roads, stones and glass. All can result in pressure loss.

Canada's cold winters present unique challenges for tire installers. For example, on a –10°C day, the ambient air temperature in the service department may be 15°C, a difference of 25°C. Therefore after the car leaves the shop, air pressure in the tires will reduce because of the drop in temperature. Professional installers compensate for the difference by adding the appropriate amount of additional air pressure. This is often referred to as "winter air."

Figure 3: Tire Under Inflation Is Difficult to See

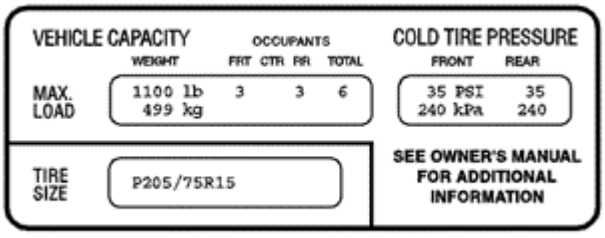


It is not possible to tell whether a tire is under inflated simply by looking at it (see Figure 3), except in extreme cases. Drivers should buy and use a good quality tire pressure gauge. Air machine gauges at service outlets are often inaccurate due to the rough use they receive.

Know the Correct Pressure for Your Vehicle

Caution: The "*maximum tire pressure"* marked on the tire sidewall refers to the pressure required to carry the maximum load of the tire, and is generally **not** the same as the "*recommended tire pressure"* for your specific vehicle. To find the recommended tire pressure for your vehicle's tires, refer to the tire information placard (see Figure 4), which is normally located on the edge of the driver's door, the doorpost or another conspicuous location. If you cannot find the vehicle placard, check the owner's manual.

Figure 4: A Typical Tire Information Placard



The placard on your vehicle could differ from this illustration. However, you should be able to retrieve the same information.

Measure Tire Pressure When the Tires Are "Cold"

All tire and vehicle manufacturer recommendations are based on cold pressures. "Cold" means that the tire has been stationary for at least three hours or has not been driven more than 2 km. A tire will warm up by as much as 35°C in normal operation, depending on the road surface and the type of driving. Most tires reach an equilibrium temperature after about an hour of driving.[11]

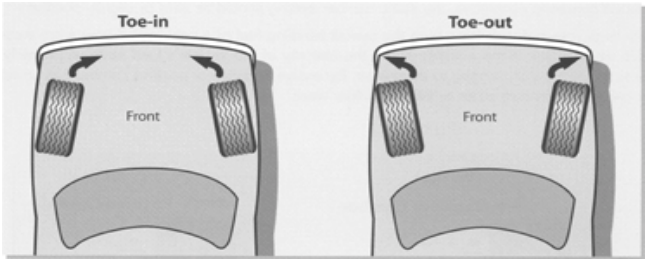
Measure each tire's pressure (including the spare tire) when cold at least once a month (or any time there is a sudden change in temperature.) If your vehicle has a temporary spare, note that the specified air pressure, as indicated in the owner's manual or on the vehicle information placard, is higher than for the tires on the vehicle.

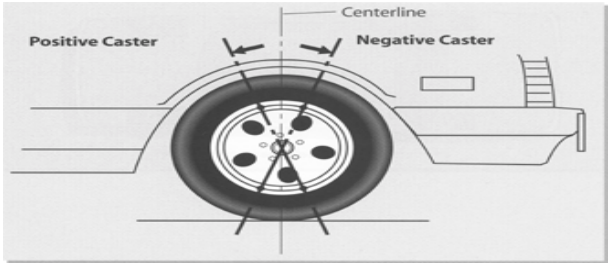
C. Wheel Alignment

Wheel alignment should be checked every 25 000 km.

Wheel alignment refers to how the wheels are set relative to the main driving axes of the vehicle. Alignment consists of toe, camber and caster (see Figure 5); and if any of these is out of adjustment, the tires will drag instead of rolling freely. This will increase fuel consumption, reduce tire life and cause handling and ride problems.

Figure 5: Toe, Camber and Caster





Symptoms of poor alignment are that the steering pulls to one side or that there is excessive wear on the inside or outside edges of the tire. If you are driving at low speed on straight and level ground, such as in an empty parking lot, and slowly release the steering wheel, your vehicle should continue to travel straight ahead. If it pulls to one side, it could need its alignment adjusted. Pull can also be caused by an under-inflated tire or a dragging brake, both of which waste fuel.

Wheels could be knocked out of alignment at any time by hitting potholes, curbs or other obstacles. Alignment should be checked once a year, or every 25 000 km. Check your owner's manual.

Steering and Suspension Components

The tires act as an extension of the car's steering and suspension.

The shock absorbers are there to dampen vibration (it's the springs that absorb most of the shock from a rough road, with the tire helping out) and to keep all four tires in contact with the road surface. Struts are suspension components that include the shock absorber and the spring in one unit. There are also various steering linkage components that wear over time. Any excess wear in these components could mean that alignment settings cannot be maintained, affecting handling and resulting in premature tire wear and increased fuel consumption.

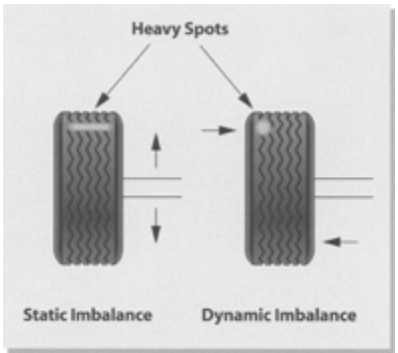
D. Tire Balancing

Tires should be balanced approximately every 20 000 km, or when drivers feel a vibration.

A typical tire and wheel assembly weighs about 20 kg (44 lbs.). A difference of as little as 14 grams (½ oz.) in the distribution of the overall mass of the assembly is enough to cause a vibration or "shimmy." A vibration felt in the steering wheel suggests that the front wheel is out of balance (has an imbalance), whereas vibration felt in the driver's seat usually means the rear wheel is out of balance (has an imbalance).

To balance your wheels, trained professionals use a Dynamic wheel balancer. Small lead weights are added to the rim to bring the wheel into balance, eliminating both up-and-down (tramping) movement caused by static imbalance, and side-to-side (shimmying) movement caused by dynamic imbalance.

Figure 6: Wheel Imbalance



The fuel economy cost of having one or more tires out of balance is hard to estimate, as it depends on the degree of imbalance and the type of driving. However, because the vehicle now has to overcome a vibration component as well as rolling resistance, there is clearly a fuel economy penalty.

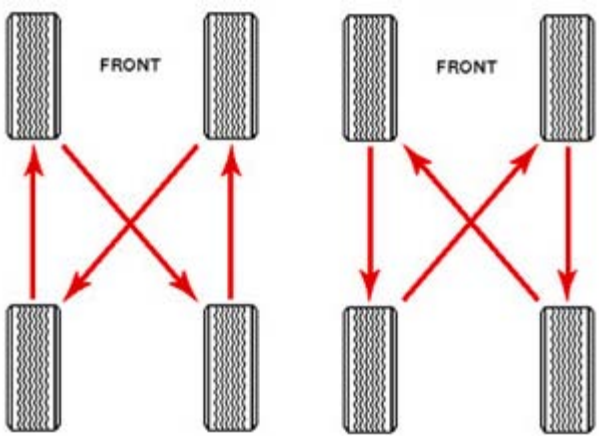
There is also a vehicle maintenance issue. At highway speeds, a typical passenger tire rotates at 14 times per second. Out-of-balance tramping and shimmying will shorten the life of other suspension components and will produce uneven tire wear. Out-of-balance tires can exhibit "cupping," a wear pattern that looks like a series of bald spots around the tire's circumference.

E. Tire Rotation

Rotate tires according to the vehicle owner's manual for maximum tread life.

The front tires work harder as they must bear the scrubbing action of steering as well as rolling wear. This wear is increased in the case of a front-wheel-drive vehicle. Rotating the tires, so that the front tires become back tires for part of their life, will prolong the service life of all tires. If a full-size spare is available, it should be a part of the rotation pattern, which is described in the vehicle owner's manual. Common practice is to rotate tires every 8 000 to 10 000 km. Always consult your owner's manual before rotating the tires.

Figure 7: Suggested Rotation Patterns



Front- and Four-Wheel Drive Rear-Wheel Drive

Note: Vehicles with different size tires on front and back and vehicles with a full-sized spare require different patterns. Consult the owner's manual for details.

F. Tire Repair

Any tire that has received a puncture in the tread area, or has been driven for even a short distance at very low pressures must be demounted and inspected for damage by a tire professional. Punctures and nail holes up to 0.6 mm (¼ inch) in diameter in the tread area may be patched permanently from inside the tire. A combination patch/plug, which seals the innerliner of the tire and seals the actual puncture so that salt and moisture cannot get into the tire plies, is necessary. Consult a tire professional for the manufacturer's recommendation before attempting sidewall repairs.

Caution: Speed Rated tires can be repaired, but such repair may reduce or void the speed rating. Consult a tire professional for advice.

G. Tire Storage

Tires should be stored upright in clean conditions, free from exposure to sunlight or strong artificial light, heat, ozone (electrical motors) and hydrocarbons. If stored on rims, the tire pressure should be reduced to approximately 96 kPa (15 psi) to avoid possible cracking and deformation.[12]

5. Key Points to Remember

1. Properly maintained tires are safer, more comfortable, last longer and use less fuel.
2. Reducing fuel consumption and increasing tire life has a significant and positive impact on the environment and saves money for drivers.
3. Under inflation is the leading cause of tire failure and a major contributor to excessive fuel use and rapid tire wear.
4. [12]Air pressure should be measured, and tires inspected, at least once per month.
5. Tire pressure should always be measured when tires are "cold."

References

[1] Rubber Association of Canada 2003 Tire Survey

[2] Rubber Association of Canada

[3] Rubber Association of Canada

[4]StatsCan, Canadian Vehicle Survey, Quarter 4, 2002

[5]StasCan, Energy Statistics Handbook, Quarter II, 2002

[6] Studies by the Shell, Environmental Protection Agency (USA), and tire companies such as Michelin and Bridgestone as referenced in technical support information.

[7]Prepared by Natural Resources Canada, Office of Energy Efficiency, using data referenced in 5 & 6.

[8] Pirelli & C.S.p.A.

[9] Transport Canada

[10]Tire Industry Council

[11]Tire Industry Safety Council, Motorist @ Tire Care and Safety Guide, 1995

[12] European Tyre and Rim Technical Organisation 2002